Western Engineering

VOL. 2 SAN FRANCISCO, MAY, 1913 NO. 5

PUBLISHED MONTHLY BY THE WESTERN ENGINEERING PUBLISHING CO. AT 420 MARKET STREET, SAN FRANCISCO.

Entered as second-class matter, June 1, 1912, at the post-office at San Francisco, California, under Act of March 3, 1879

Telephone Kearny 4777. Cable Address: Pertusola. Code: Bedford McNeill (2 editions).

BRANCH OFFICES:

CHICAGO—734 Monadnock Building. NEW YORK—29 Broadway.
LONDON—The Mining Magazine, 819 Salisbury House, E.C.

ANNUAL SUBSCRIPTION:

United States and Possessions, and Mexico..... $3
Other Countries in Postal Union 4

CHARLES T. HUTCHINSON, Editor L. A. GREENE, Business Manager H. L. QUIGLEY, Advertising Manager

TABLE OF CONTENTS

EDITORIAL: Page.

Notes 345
Electrical Engineers and Fellows..... 348

REVIEW OF THE MONTH 349

ARTICLES:

Concrete Slab Flume Construction—Part I.....*S. L. Stovall* 353
Manufacture of Gasoline from Natural Gas.....*Charles T. Hutchinson* 363
Concrete Pavement by Day Labor at Chehalis, Washington.....*F. O. Blair* 370
A Reinforced Concrete Railroad Bridge .....*W. P. Day* 373
Cost of Water per Acre 379
Geologic Notes on Santa Susanna District.....*Henry R. Johnson* 383
Oil Well Supply Houses Needed in Mexico.....*Thomas H. Bevan* 386

THE ENGINEERING DIGEST:

Concrete Pavements .....*Carl M. Boynton* 387
Modern Street Railway Track Construction.....*C. B. Vorce* 392
Concrete and Reinforced Concrete 396
Generator and Prime Mover Capacities.....*David B. Rushmore* and *Eric A. Lof* 401
Columbia River Power Project.....*L. F. Harza and V. H. Reineking* 406

COMPANY REPORTS 412

ENGINEERING BONDS 413

ENGINEERS' NOTE BOOK:

Measuring the Flow of Air in Pipes.....*G. G. Crewson* 414

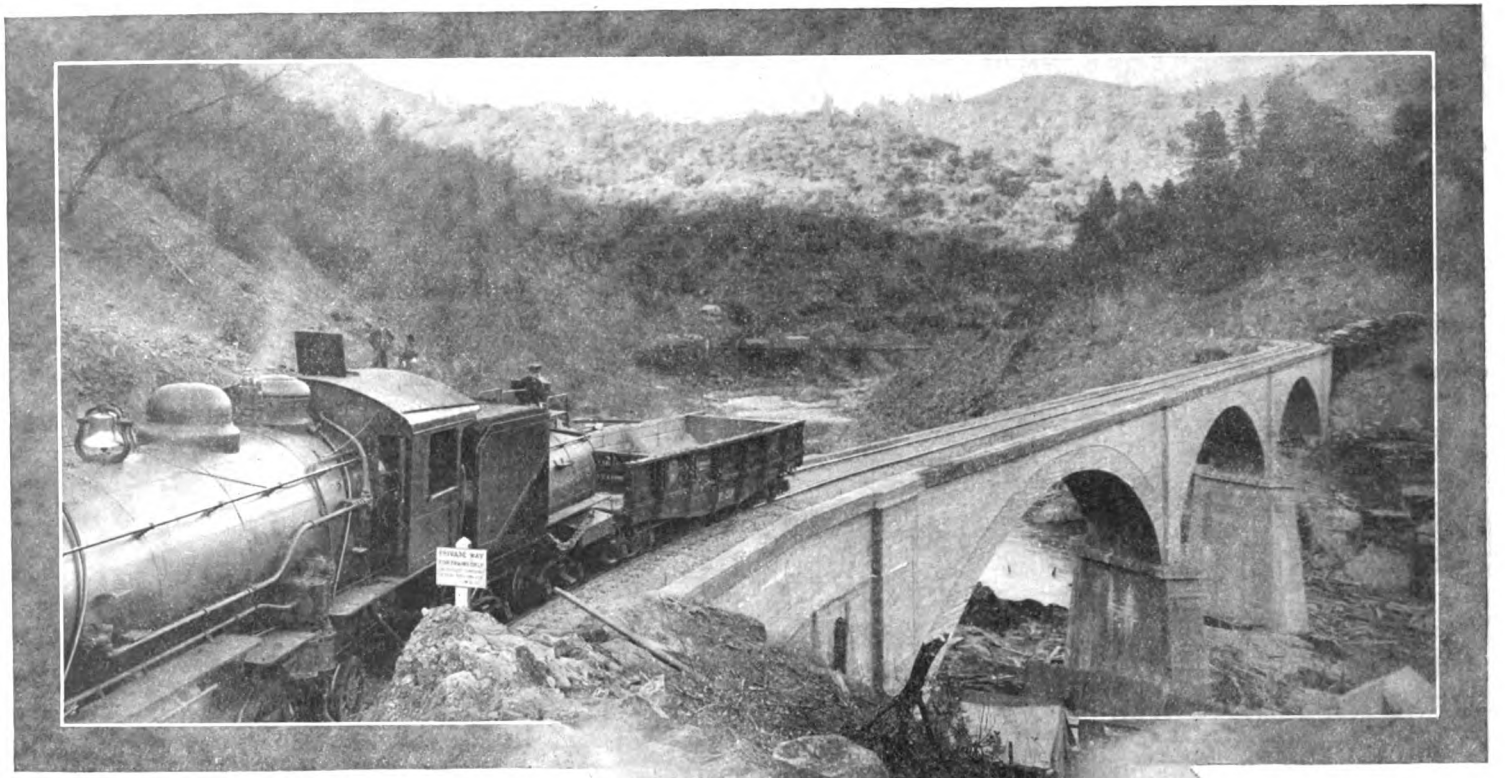
HINTS ON PRACTICE:

Corliss Governor Troubles .....*F. C. Holly* 415

BOOK REVIEWS 417
INDUSTRIAL PROGRESS 418
ENGINEERING NEWS 419
SOCIETY MEETINGS 425
PERSONAL 425
CATALOGS RECEIVED, COMMERCIAL PARAGRAPHS 426

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google



REINFORCED CONCRETE RAILWAY BRIDGE OVER THE AMERICAN RIVER.

(See page 373.)

Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

EDITORIAL

APPOINTMENT of Mr. A. M. Hunt to be Chief of the Department of Machinery of the Panama-Pacific International Exposition, assures a most competent man for a most important job. Mr. Hunt's wide experience in mechanical and electrical engineering and his broad general knowledge especially qualify him for the work. He is to devote his whole time to the work for six months, and the management hopes then to secure his services for the remaining period of the Exposition.

STRUCTURAL engineers are asked to coöperate with the Seismological Society of America, of which Mr. John C. Branner of Stanford University is president, in observing and recording earthquake phenomena. The importance of such data to those contemplating erection of buildings, dams, docks, or indeed any large structures, can hardly be overestimated. There is no official bureau for collection of the data and the Society must depend upon voluntary observers. Those interested are urged to correspond with Mr. Branner.

MATERIAL improvement in the condition of the Ocean Shore Railway is indicated by the annual report distributed this month. For the first time the income account shows a small surplus and, while the officers frankly state that the system is deficient as regards terminals and equipment, both are being improved. Considering the fact that the two ends of the line have never been joined, Mr. F. W. Bradley and his associates in the management are to be congratulated on having done so well. The Ocean Shore has large possibilities despite the fact that the immediate future looks discouraging.

CONCRETE has been used for building many small bridges, but its value in construction of large railway bridges is less widely known. The American river bridge shown in our frontispiece was built by the Mountain Quarries Company to carry heavy Mallet compound engines and standard equipment. It cost 20 per cent less than the figures for an equivalent steel structure. Full details are given by Mr. W. P. Day on another page.

SPRING styles in California state legislation include a bill introduced in the Assembly to put gasoline venders in red cans. We are glad to note that, after passage, the bill was reconsidered and amendments adopted substituting gasoline in place of the venders thereof. It hardly seems fair to have singled out gasoline venders alone for the distinction when so many men in other walks of life are more worthy of this attention. And, while we are on this subject, why not can a few state legislators? That would be more to the point.

CO-OPERATION between state and nation in development of power and reclamation projects, urged in an article by Mr. John H. Lewis, that we printed last month, has received a strong impetus from the contract just made by Mr. F. K. Lane, Secretary of the Interior, acting for the United

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

States, and the state of Oregon. The Secretary agrees to withdraw the necessary land, and the State Engineer to hold the water for any project under investigation. The expense of surveys and investigations is to be divided. The sum of $100,000 is made immediately available for construction on one of the units of the Deschutes river project, and expenditures totaling $8,000,000 are contemplated. Another interesting project being studied is that of power development at The Dalles on the Columbia. Details are given on another page, being taken from one of the bulletins prepared under direction of Mr. Lewis, the State Engineer of Oregon, and the one to whose initiative the present satisfactory arrangement is due.

WATER and its cost per acre is a live subject in all the arid and semi-arid districts. There has been a general impression that under projects of the United States Reclamation Service the cost was higher than under private projects. That this is not true in any general way is indicated by figures that we print this month. According to these, the cost per acre is about $12 less on the United States projects, despite the admittedly excellent character of the construction. Taking into account interest charges, the showing from the settler's point of view is even more favorable. We have already suggested that such dissatisfaction as has been voiced in comparing the Reclamation projects with those built privately, is in large part due to the impossibility of the Reclamation Service choosing the settlers on its projects. The time for repayment, too, of the cost of the work, is unnecessarily short; much shorter indeed than Australian states have found it expedient to require. These are matters to be changed by Congress and are hardly to be blamed upon Mr. F. H. Newell and his capable and hard-working associates of the Service.

FLUME construction is a matter of large and growing importance throughout the West, and flume maintenance is a serious source of worry and expense to operating men at many a plant. Usually a flume twice as long gives twice as much cause for anxiety, but right methods of construction may greatly minimize the trouble. Wooden flumes have been built generally because of local abundance of material and lower first cost, but concrete is making a place for itself in this as in other construction. We print this month the first part of a description of a concrete slab flume built by Mr. S. L. Stovall for the Mt. Whitney Power & Electric Company. The importance of the method that Mr. Stovall has devised lies in the circumstance that a concrete flume may be built along these lines, in most situations, as cheaply as can one of wood. In many places the cost will be less. It goes without saying that repairs and maintenance will be greatly less in almost any situation.

LEVEES and levee construction are exhaustively discussed in a report upon the Mississippi river flood conditions of 1912, prepared by Messrs. Haviland, Dozier, and Tibbetts of San Francisco and distributed by the West Sacramento Company. It is especially interesting to have this study of Mississippi Valley conditions and methods by outside engineers of experience. They note that the Army engineers, who are in charge of work along the Mississippi, seem opposed to the 'by-pass system', a matter upon which we comment elsewhere. The Mississippi levees are built

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

mainly by hand, but in part by use of team and scraper. This is only possible where labor is cheap, and the system has many drawbacks at best. The large long-boom clam-shell dredges used in California are not employed at all, and the bucket scrapers are just coming in. On the Mississippi, continuous barrow pits on the river side are avoided, but the traverses that interrupt them seem as prolific a source of eddies and consequent danger as on the Colorado. The levees built on the Mississippi are wider at the bottom, narrower at the top, and have a wider berm than is customary in California. They need less protection against scour, and they suffer from having generally been built in stages, new work upon older and imperfect embankments. The whole report is most interesting and valuable and shows that local builders are taking full advantage of experience gained elsewhere.

ENGINEERS will be glad to learn that substantial progress is being made in the organization of the Panama Pacific International Engineering Congress. The general committee, which includes representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers, has effected an organization in two divisions. The Eastern members consisting of the presidents and secretaries of the participating societies, constitute the committee on foreign participation. Of this, Mr. C. F. Rand is president and Mr. C. W. Hunt secretary. The San Francisco members form the executive, finance, papers, publicity, and local affairs committees. Of these the chairmen are Messrs. W. F. Durand, W. G. Dodd, A. M. Hunt, W. A. Cattell, and E. H. Benjamin, respectively. Mr. Durand is president, and Mr. Cattell secretary, of the general committee or 'Board of Managers' as it is called. Honorary officers of the congress will consist of a president and a number of vice-presidents selected from among the most distinguished engineers of this and foreign countries. While the scope and magnitude of the congress have not yet been definitely fixed, it is expected that the papers will in the aggregate present a picture of the state of the art in all lines of engineering in 1915. Papers will be read by invitation only, though participation in the congress itself is open to all.
to the Board of Directors.

ESPERANTO is proving its usefulness in many directions. The International Scientific Esperantist Association, whose aim is the propaganda of this international auxiliary language at the hands of scientists and technologists, and to facilitate its use by developing its usefulness, is divided into sections of specialists, among which an engineering section recently has been organized, with Sinjoro Stromboli, 3 via Gropallo, Genoa, Italy, as secretary, to whom all interested should write, in Esperanto, of course. Membership in the Association, including subscription to its official organ, *Scienca Gazeto*, costs only two dollars per year, and puts all who read Esperanto in touch with the best scientific work of the Old World. Communications concerning the *Gazette* subscriptions, announcements, etc., should be sent to Hachette et Cie., Boulevard Saint Germain, 79, Paris VI; and concerning membership, including yearly dues, should be sent to Rollet de l'Isle, 35 Rue du Sommerard, Paris.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Electrical Engineers and Fellows

The *Proceedings* of the American Institute of Electrical Engineers for April 1913, pages 127 to 139, contains a signed statement by Mr. Ralph D. Mershon, the president, and some supporting correspondence, all bearing on what is considered to be the most serious crisis in the affairs of the Institute that has yet arisen.

At the last annual meeting the constitution and by-laws were amended to provide for an advanced grade of membership—'Fellow'—admission to which presumably was to be secured only by those engineers whose professional attainments and practical experience place them in a more advanced class than those ordinarily included in the grade of 'Member' under the original constitutional provisions. At least, this was the theory upon which the proponents of the constitutional amendments placed themselves before the electors of the Institute. The regularly constituted machinery for transfer from one grade to the next advanced is, as usual, through a Board of Examiners that investigates the claims of the applicant and reports its findings to the Board of Directors.

To general surprise, no sooner were these amendments passed and in effect than the present Board of Directors interpreted a special section of the amended constitution to mean that practically anyone in the then existing grades could be transferred to the next higher grade without passing the examination of its Board of Examiners, or without any inquiry into their references, and the Board of Examiners was forbidden to exercise its constitutional functions, all requests from it to the Board of Directors in this regard being refused. The result was that some members took advantage of the situation to secure their transfer to advanced standing, that otherwise would not have been transferred. Flagrant in this respect are the cases of two very prominent Eastern men of high financial standing and great reputation as executives of large corporations, neither of which has ever been known as an engineer and one of which has denied in public that he is an engineer.

Finally, three of the most prominent members of the Institute, Messrs. Louis Duncan, Francis B. Crocker, and Michael I. Pupin, have summoned the Board of Directors into the Supreme Court of the State of New York, where there is now being argued a motion for an order enjoining and restraining the Board of Directors from transferring or electing, or from recognizing as belonging to the higher grades of 'Fellow' and 'Member', any and all persons who hereafter shall apply to be transferred or elected, or who have been transferred or elected thereto without passing the examination of the Board of Examiners, or without any inquiry into their references, and from allowing them to exercise and enjoy the rights and privileges of such grades of membership.

Thus one of the leading engineering organizations of this country is being made a defendant in court to compel its officers to keep its own advanced grades free from taint. The spectacle is one that has excited the derision of some of our foreign professional men, and is one that well may cause the entire engineering fraternity of this country to be very careful about amending fundamental constitutional provisions, even when the proposed changes are advocated by skilled, eloquent, and talented gentlemen.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

REVIEW OF THE MONTH

FLOODS and flood control have been uppermost in public thought the past month. Unprecedented rainfall in New York, Pennsylvania, and the states of the Upper Mississippi Valley caused the rivers to rise rapidly and to overflow their banks at many points. Hundreds of cities and towns were inundated, and the transportation system of the whole region broke down. While popular attention has been focused mainly upon Dayton, Ohio, because of the dramatic features of the flood at that point, the suffering and loss in that city was, after all, but a small part of the total damage done. It is too soon to attempt to give figures, but many millions of dollars' worth of property has been swept away.

RIVER TOWNS, from such inland points as Indianapolis to New Orleans, have been in terror of destruction, where not actually damaged, as the great flood of waters has swept to the Gulf, gathering bulk as it journeyed. Against such mighty forces as have been playing in the Middle West these last weeks, the power of man seems feeble; and yet, is it really impotent? It may be granted at once that no plan for levees or reservoirs yet seriously discussed would have wholly prevented damage from the flood of 1913. At the same time it is to be remembered that no dam of consequence broke, and, while there were failures of levees, there were also cities and farms that were saved by the stout embankments that have been raised by man. At Dayton the levee was overtopped by an unexpectedly high flow of water. The fault was not with the works, but the knowledge upon which they had been planned.

RECORDS of stream flow and flood height are admittedly incomplete, but engineers can even now protect the Mississippi Valley from flood damage, if given the authority and the funds with which to build the necessary works. It is mainly a matter of dollars and cents, of measuring cost against probable damage. It would be necessary before adopting any system of construction to fill the gaps in existing knowledge, but it is not to be forgotten that present knowledge is not being utilized. As the *Engineering Record* has pointed out in an admirable editorial discussion of the subject, the trouble at Dayton resolved itself with insufficient spillway. Running water requires space in which to run, and indefinite raising of levees will not serve alone to meet flood conditions. In the flood of 1912 the total discharge passing Memphis was estimated at 2,000,000 second-feet. It was not to be expected that this flow could have found its way to the Gulf without some relief along the way, and yet the Mississippi flood was but caused by combination of minor floods along numerous tributaries, none of which was at record stage. If ever the Missouri, Ohio, and upper Mississippi reach record heights at the same time, the lower Mississippi will experience a flood that is a flood.

CURES can only be made permanent by removal of causes. Levees, useful as they are, do not prevent floods.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Rather, by narrowing the water line they raise the crest, and to that extent aggravate the trouble. Nature's way was to regulate the run-off by means of forrested slopes and to care for such floods as were inevitable by temporarily broadening rather than constricting the channels, and men do better to work with rather than against nature. Just a year ago last month we printed the details for such a system, as worked out for the Sacramento river by Mr. C. E. Grunsky and his associates. The 'by-pass' system is the natural method of handling a flood once formed, and it is of interest to note that in the report on the Mississippi flood of 1912 by Messrs. Haviland, Dozier & Tibbetts, discussed elsewhere, these independent and competent engineers question the final solution of the problems of the Mississippi without deliberate provision of by-passes.

PREVENTION is admittedly more important than cure, and for flood prevention only one system is available. Reservoirs at the headwaters, temporary storage of the excess rainfall, afford the only known means of meeting this situation. Mr. M. O. Leighton, of the United States Geological Survey, has outlined in some detail a system of reservoirs for the Mississippi and its tributaries. His plan has been criticized at points, but in essence it is sound, and, taking into account profits from water power, improved navigation, and land reclamation, in addition to relief from flood damage, the financial aspect of the proposal is by no means hopeless.

NATIONAL problems require national action, and surely flood control and land drainage are problems big enough to command the attention of the whole people. At the National Drainage Congress, which met at St. Louis last month, the related problems of stream control and land reclamation received earnest consideration. It was felt that a nation that can spend hundreds of millions wisely and economically on a Panama canal, can be trusted to protect its bottom lands from overflow. Millions of dollars have been spent already, but not all of it wisely. Mr. Isham Randolph, who has given much consideration to the subject, presented a plan for a National Department of Public Works, of which the head should be a member of the cabinet at Washington. He supported his proposal with many cogent reasons. Readers will recall a similar proposal by Mr. C. E. Grunsky that we discussed last year. It can be stated without fear of successful contradiction that, whether these plans or some other plan be adopted, no satisfactory solution will be found until the problem of our rivers is recognized as national and the river and harbor bill ceases to be chiefly important for the 'pork' it contains. Mr. Francis G. Newlands, the extremely useful senator sent by Nevada to Washington, but who represents the whole West, has prepared a comprehensive bill providing one method of national river regulation.

PROGRESS as well as destruction has marked the month just closed. In the important matter of the relation of municipalities to public utilities, several significant events have fallen within the period. At San Francisco a plan has been worked out for acquirement by the city of the Spring Valley properties so far as they are needed for the purpose of water supply, on the basis of condemnation and friendly suit. Too much time and energy have already

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

been devoted to this matter, and we are glad to see the city and the company in agreement at last. A most hopeful sign of the times was the approval by public vote of the arrangement between the city of San Francisco and the United Railroads, whereby the difficulties on lower Market street are to be settled. Under the terms of the contract both the Sutter street and the Geary street cars are to run to the ferry; which is plainly in the interest of the public. This is satisfactory in itself, but it is even more pleasing as an indication that a fair agreement reached by the Mayor and his associates on the one hand, and officials of the company on the other, will be endorsed by the public. The importance of this lies in the need of joint action if adequate transportation facilities are to be provided for visitors to the Panama-Pacific Exposition. In a detailed report upon municipal railways to meet this need, Mr. M. M. O'Shaughnessy, city engineer, has shown that there is barely time within which to construct such a system, even allowing for no changes in plans or unreasonable delays. He also shows that if the city undertakes to build and equip a separate system, the cost will be out of proportion to all possible profits, and the close of the Exposition will find the city with a load of equipment far beyond its need for many years. By coöperation, however, with the United Railways, suitable additional lines can be built and operated at reasonable profit. The chief obstacles to coöperation have been the stigma resting on the company from an ill-spent past, and the burden carried by the city in the form of "doctranaires and a millionaire." We are glad to see signs of a better spirit prevailing. Chicago, this month received $2,500,992 as its share from street railway operation last year, and since 1907, when the present arrangement was made, has received $10,334,200, which with accrued interest gives a sum of nearly $11,000,000 available for subways. In the meantime the companies have spent $80,000,000 on betterments with profit and apparent satisfaction. Surely the Chicago way is justifying itself.

LOS ANGELES, in the meantime, has decided to pause and take second thought before going further along the road of municipal ownership. With a magnificent aqueduct, splendidly built, the disposition of water power and local distribution of surplus water affords sources of potential revenue of first rank. Whether to sell wholesale to existing companies or to compete in the retail business has been much debated. To carry out the latter project additional funds were necessary, and at the election of April 15 the necessary majority for the bonds was not secured. At the same time a scheme for a municipal railway and various other projects were voted down. The bonds necessary to build a trunk channel to carry water into the city carried, as did also those necessary to complete the harbor improvement now under way. Evidently our neighbors to the south are in no hurry to embark on new fields of municipal activity, despite the success that has followed their earlier ventures. We believe them wise. Useless duplication of plant and organization is uneconomical, and honest patient endeavors will usually permit of negotiation of fair contracts with companies already in the field.

RAILWAY earnings are becoming more satisfactory, though there is still some question whether proper pro-

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

vision is being made for new capital. According to the figures of the Bureau of Railway Economics, the net operating income of all the lines increased 4.7 per cent in 1912. All the groups except the southern showed an increase in this vital figure. The western roads did especially well with an increase of 8.4 per cent. The southern roads enjoyed an increase in operating revenue, but were unable to show any improvement in net. Something of the size of the business is reflected by the figures for the year of 229,058 miles, $2,923,936,957 operating revenue, $912,845,121 net operating profit, $120,026,062 taxes, and $794,266,732 net operating income. The January figures, while showing the customary decrease for the month, indicate a comfortable gain over January 1912.

ELECTRIFICATION of transcontinental railways seems to be the order of the day in the Northwest, and following the ambitious program outlined by the Chicago, Milwaukee & Puget Sound comes the announcement that the Great Northern will spend an even larger sum in the electrification of its lines in Washington. The Great Northern has already a small hydro-electric generating plant at Leavenworth for operating trains in the tunnels through the Cascade range, and it is now announced that a large plant will be built on the Chelan river, east of the Cascades, making it possible to operate the line across the range entirely by electricity. Later other plants will be built and the whole line electrified from Montana to Puget Sound.

SALE of the Nevada County Narrow Gauge railroad by Mrs. S. A. Kidder is announced, and California is to lose her only woman railway president. The little railroad that finds its way along the edge of the hills from Colfax to Nevada City has had many picturesque features, not forgetting the rival auto-stage line operated one season by a woman who would have wrested from Mrs. Kidder the proud position of social eminence that possession of the town's only railroad gave. It is reported that the Narrow Gauge has been bought by men affiliated with the Oakland, Antioch & Eastern, which, by the way, is reaping a harvest while citizens of Alameda county are getting acquainted with the country beyond the hills.

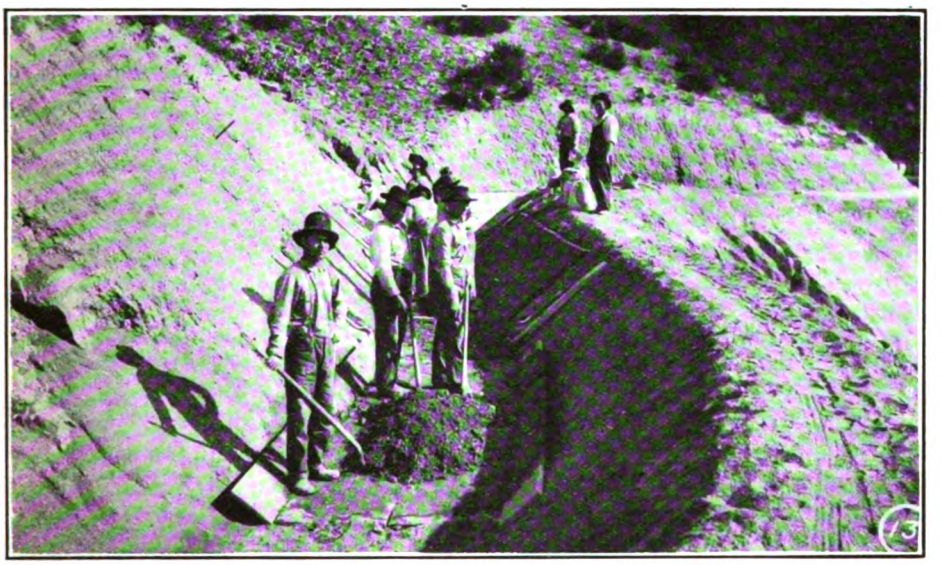
LEGISLATION of many sorts has been under discussion through the month, both at Washington and various state capitals. Congress has been busy with the tariff and drastic changes seem now certain. Business men, while looking with apprehension at the result, seem to have reached the conviction that the revision will be honest and that in any event nothing is to be gained by protest. Gradually it is coming to be felt that no great harm and much possible good will result. Besides, with customers waiting, who has time to talk politics? At Sacramento an alien land bill has absorbed undue attention. The proposal to require packing of portland cement in dust-proof containers was defeated. The Workingmen's Compensation and Water Commission bills are under debate at this writing, but seem certain to pass. Provision has been made for organization of oil districts corresponding to reclamation districts, and which will permit of effective work in excluding water from the oil sands. Funds are to be provided by local assessment based upon acreage and production.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Concrete Slab Flume Construction—Part I

By S. L. STOVALL*

IN the fall of 1908, as chief electrical engineer, I designed a hydro-electric power-plant on the Tule river, about 22 miles east of Porterville, Tulare county, for the Globe Light & Power Co., which afterward was merged into the Mt. Whitney Power & Electric Co. The power-plant had about seven miles of conduit line and nearly 3000 ft. of pipe-line. The gross operating head is 1136 ft. Two 1800-hp. water-wheel units, each direct-connected to 1000-kw. electric generators, were installed, and provision was made to double this equipment later. The conduit line ran through a very rough country, hard granite cliffs being exposed for a great part of its length, and precipitous granite cliffs were not uncommon. I recommended an all-concrete conduit, having in mind a scheme to bench the rough places and line the bottom and uphill sides with concrete; the downhill sides to be a retaining-wall formed in place, supported as a cantilever with the bottom and also by abutments or pilasters placed 12 to 16 ft. apart on the outside of the wall. Where excavation was easy a trapezoidal ditch lined with concrete was contemplated. At that time it was the intention to set the conduit on the ground, as it was believed that to attempt to make a concrete flume in place would be an ex-



CONCRETING DITCH ON TULE RIVER.

*Electrical and Hydraulic Engineer, 417 Foxcroft Bdg., San Francisco.

Generated on 2024-09-30 00:07 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

cessively expensive undertaking.

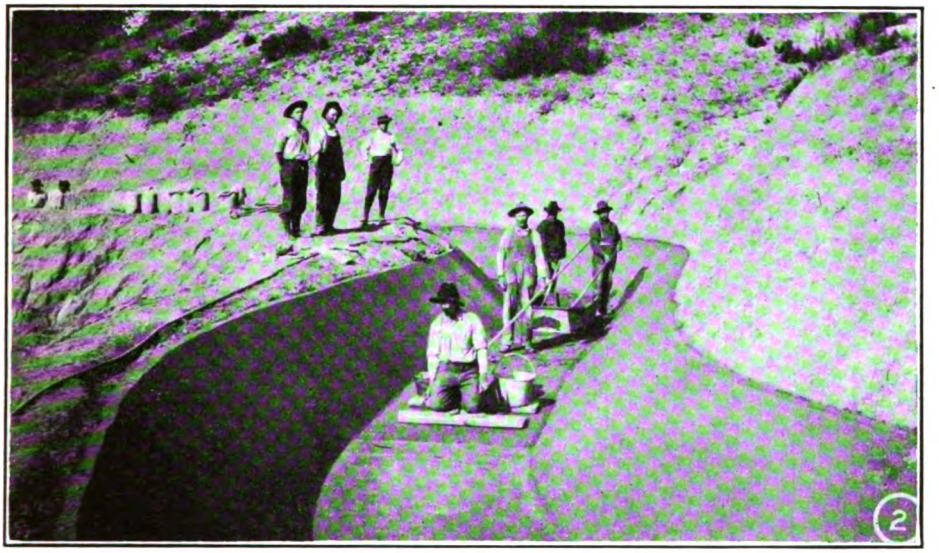
Just a few years before, the company had an unfortunate experience with a concrete-lined trapezoidal ditch. This ditch had a thin coating of mortar which gave continuous trouble and had to be replaced later with a thicker coating of concrete. This is the reason why the scheme for a concrete conduit was received with but little favor. Permission was finally granted, however, to make as much of the conduit a concrete-lined ditch as, with reasonable certainty, could be put in as cheaply as a wooden flume. After several careful examinations of the conduit line were made, it was decided to install 2½ miles of concrete-lined ditch and the balance of 4½ miles a wooden flume. The ditch line was run on a grade of 1 in 1000, and was excavated so as to be at least 2 ft. in solid cut on the downhill side at all points. It was lined 3 in. thick with concrete, which was made smooth with mortar and given a trowel finish. The finished dimensions were 4 ft. 6 in. wide on the bottom and 3 ft. deep, with the sides sloping 1 on 1. The flume was run on a grade of 2 in 1000. It was constructed of pine, surfaced on one side, and was 4 ft. wide and 3 ft. deep.

When water was first turned into the conduit, measurements were made and the coefficient of roughness in the case of both the ditch and the flume was determined approximately to be $n = 0.0015$. The water of the Tule river, however, is highly impregnated with calcium carbonate, especially during low-water season. At the end of twelve months the sides and bottom of the flume had become coated to such an extent that the coefficient had been altered to $n = 0.0022$.

Conditions were unfavorable to the economical construction of the concrete-lined ditch. Sand was hard to get and of a rather poor quality, and it all had to be hauled three to four miles over a heavy mountain grade. The rock also was poor. Part of it was broken by hand, part with a little jaw-crusher, and for at least one-third of the ditch, river gravel was hauled some two miles. As none of this material was screened, the work of mixing and placing amounted to more than it should. The worst condition of all was that the ditch had been laid out from the standpoint of easy excavation only. In consequence, the conduit line, instead of being made up of one long piece of wooden flume and one long piece of concrete-lined ditch, was made up of a great number of short pieces of each, it having been decided to build the concrete-lined conduit in pieces as short as 100 ft. Delivery of concrete material and lumber from the same hoisting station is difficult, particularly so with the former, which has to be stored at the head of the hoist till the flume is built so that it can be hauled out through the flume. I would hesitate to undertake the construction of another conduit line, of which part was to be concrete-lined ditch, and part timber flume, particularly if the material had to be hoisted and delivered along the conduit line as was the case with the Tule river job. Another thing that caused considerable worry was that most of the concrete was mixed and placed in very hot, dry weather. The ground was very dry, the concrete, especially that for plastering the sloping sides, was mixed dry, and the dry ground soon absorbed even the little moisture that was in the concrete. It was not possible to keep the concrete wet after being placed, as the trowel finish was spoiled if it was not allowed to set for at least 24 hours. It was feared that the concrete, under these conditions, would cure in a very un-

Generated on 2024-09-30 00:14 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

satisfactory manner. In spite of all the odds against it, the concrete-lined conduit came out satisfactorily, was a good piece of work, and has been in use for five years without repairs. Although the flume was built of a very poor grade of mountain pine, and had only one-half the cross-section of the concrete-lined ditch, the meagre cost data available at the end of the job indicated that the concrete-lined ditch had cost from $3000 to $3500 per mile accounted for by the fact that the ground was wet while the last one-third was being excavated. The labor cost of preparing and delivering concrete aggregate was about $5 per cubic yard. The cement cost, delivered at the point of use, was $5 per barrel. A 1:3:7 mix was used, and the concrete was smoothed with a 1:3 mortar. Over the mortar a little neat cement was sprinkled and then the surface was finished with trowels.



PLASTERING DITCH ON TULE RIVER.

less than the lumber flume. Further, the flume has had considerable repairs since and has given constant trouble, as is usual with lumber flumes.

The ditch was excavated almost entirely in decomposed granite, there being but little hard rock taken out. This material is easy to excavate, especially when wet, and can be trimmed to a good finish for receiving concrete plastering. The labor cost of the excavation was $1.05 per lineal foot for about the first two-thirds of the ditch, and 70c. per lineal foot for the last one-third. This difference is partly

Twelve men with a foreman made a good crew for mixing and placing the material. Three men carried the material to the mixing board, 4 men mixed the concrete and placed it in the ditch, bottom and side, 2 men with 2 helpers did the plastering, and 1 man pumped water to the mixing board, and ran errands. The best these men ever did was to line and plaster 165 lineal feet of ditch in one day. The average for over 7000 ft. of ditch was 100 ft. per working day. This average could easily have been between 135 and 150 ft. per day had it been possible to keep

Generated on 2024-09-30 00:13 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

the crew supplied with material. The total wage paid this crew was about $40 per day.

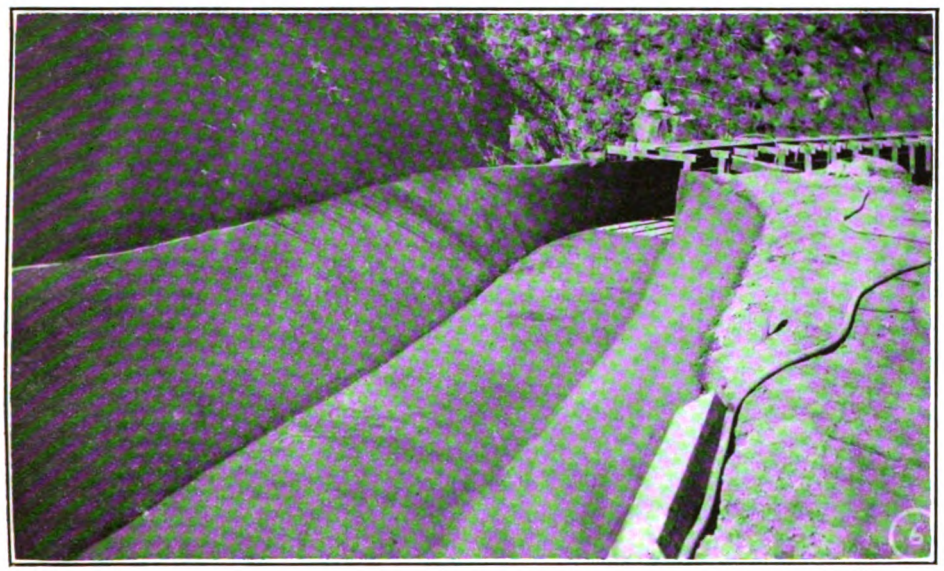
As pointed out above, in the excavation of the ditch great care was taken that the ditch at all points should be at least 2 ft. in solid cut on the down-hill side. This, at all points, gave a good foundation for concrete lining, and I believe is responsible in a large measure for the success of the ditch. The ditch which had previously given trouble was, in places, almost entirely on fill. When this fill settled, it left the concrete unsupported, the concrete cracked, and then there was a break in the ditch. Concrete, too, has a marked advantage, in this kind of work, over mortar regardless of its thickness. It is practically impossible, in work of this kind, to keep the lining from developing a great number of cracks. In the case of the mortar, when a small section of the lining cracks there is nothing to keep it in place. With concrete, a piece of the lining which may crack will be keyed in place by the stones in the mixture. This ditch has been carefully examined many times, and, so far as could be seen, these small cracks appear in no way harmful. The down-stream berm has several times been excavated back of the cracks to allow close examination, and in no case was there found to be any appreciable leakage.

The marked success of the concrete-lined ditch on the Tule river was the cause of my efforts to devise a scheme for building a conduit line entirely of concrete. Since constructing a conduit line for power plants is usually carried on along very steep mountain sides, any scheme necessitating the building of forms and the mixing and placing of concrete in place is likely to prove both troublesome and expensive. My idea at the beginning of the Tule river job of benching the rough places, plastering the bottom and uphill sides, using a retaining wall formed in place and supported as a cantilever with the bottom, and pilasters placed 12 to 16 ft. apart on the down-hill side, was given up. It was found that handling the forms would be expensive, and that for a wall 4 ft. high, nearly twice as much material would have to be used as the strength required for the wall demanded. It is obviously not practical to attempt to pour concrete 3 or 4 in. thick in forms for a 4-ft. wall. It was also determined to try to design a concrete flume so that in gulches it would not always be necessary to keep the conduit on the ground and thus have to go far back into the gulch, but to provide a design for a concrete flume that could cross these gulches supported on long legs, much after the method employed for a timber structure. Also, since the best concrete material is found in deposits along the river beds, and since all supplies are usually hauled along the river, I tried to design a concrete shape that could be easily molded in a yard close to the base of supplies and with deposits of sand and gravel near at hand. Such shapes could readily be transported to the point of use and there assembled into the finished conduit. A great variety of shapes was tried. In almost every case, these shapes consisted of short lengths of the entire cross-section of the conduit in one piece. An article appeared in the proceedings of the American Society of Civil Engineers describing the making and handling of some circular shapes used in lining the Tieton canal in Washington. An attempt was made to use these circular shapes for a flume design by casting lugs on the side for supporting them on beams. The trials referred to were, of course, all on paper. In every case the short cross-

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

sections of the entire conduit had to be carried between supports on beams. The beams, to be strong enough to support both the shapes and the water load, required more material in their construction than did the shapes themselves. After a time, the idea occurred to me to make the beams and the sides of the flume in one piece; in other words, if possible, to construct a flume which would sustain itself between supports without extra beams. It did not take long then to return to the old idea in view at the time the Tule river job was designed, and to make use of the idea of the cantilever. As finally worked out, the sides of the flume were designed as a beam to carry the structure and its water load between supports. The cross-section of these flume sides was L shaped. The short leg of the L was designed to carry the floor and was of such a length that the weight of the floor and the water would overcome the side thrust from the water and make it unnecessary to provide ties across the top of the flume between the two sides. At the same time, it was seen that these same L-shaped sides would apply well for a bench-type of construction, it being an easy matter so to tie the shape to the bottom that it would be a self-suporting retaining wall acting as a cantilever with the bottom.

In August 1911 two sections of a flume, 12 ft. long, 3 by 6 ft. inside measurement, were made. The side slabs were 3 in. thick and 3 ft. 4 in. wide down to the lip of the L. The lip itself was 3 in. thick. Resting on the lip of the L were the bottom slabs, 3 by 6 ft. and 4 in. thick. Both side and bottom slabs were reinforced with Clinton wire mesh. The bottom slabs were beveled all around, thus giving a V-shaped joint which later was filled with concrete, not mortar. The side slabs rested on caps 6 by 12 in. by 10 ft. spaced 12-ft. centres, and these caps in turn were supported on posts 12 by 12 in. On the ends of the caps were put



FINISHED DITCH ON TULE RIVER.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

pilasters 12 in. wide, 6 in. thick at the top, and 18 in. thick at the bottom. These pilasters were made of concrete after the flume was assembled, and served the purpose of closing the joints between the ends of the side slabs, adding materially to the rigidity of the structure, and giving it a very pleasing appearance. The ends of the flume were closed with bulkheads, the flume filled with water. None of its members developed weakness or defects under this load. In building the flume, however, the 12 by 12-in. posts had only been set about a foot in the ground, no adequate foundation having been provided. In a short time there was an unequal settlement of the posts, cracks opened between the ends of the side slabs, and the water leaked out, thus showing that a flume of this type must by all means have a substantial, solid foundation. The flume was then filled with earth to a height of about 6 ft. from the bottom, side boards having been put on, and a hose was played on the earth as it was shoveled in. The load was estimated at about four times that when the flume was full of water. The load of earth was left in the flume for six months, and frequent examinations failed to show any weakness in any of its members. The flume was finally taken down and the pieces hauled away.

A 12-ft. section of a flume 2 by 3 ft. was built at the same time as the other two. The side slabs were 3 in. thick and 12 ft. long, and were 2 ft. 3 in. wide to the lip of the L, the lip being 3 in. thick. The bottom slabs were 3 in. thick, 3 ft. wide, and 4 ft. long, both sides and bottoms being reinforced with Clinton wire mesh. The joints were closed and the flume supported in the same manner as the larger flume sections. The ends were closed and the flume filled with water, remaining loaded for six months until it was torn down and carted away with the other flume. Since finishing the design of the flume early in 1911, I believe that a concrete flume of any size could be built as cheaply as a timber flume, especially if the concrete material was readily available. As the flume, 3 by 6 ft., required less than 6 cu. ft. of concrete per lineal foot, and the 2 by 3-ft. flume required less than 3 cu. ft. per lineal foot, it certainly looked as if a concrete flume had been designed that required a minimum of material. The two samples showed that this design was much more rigid than one of timber could possibly be, and, as the shapes were of such a nature that the formwork could be done very cheaply, the difficulties of constructing such a flume were merely those incidental to transportation.

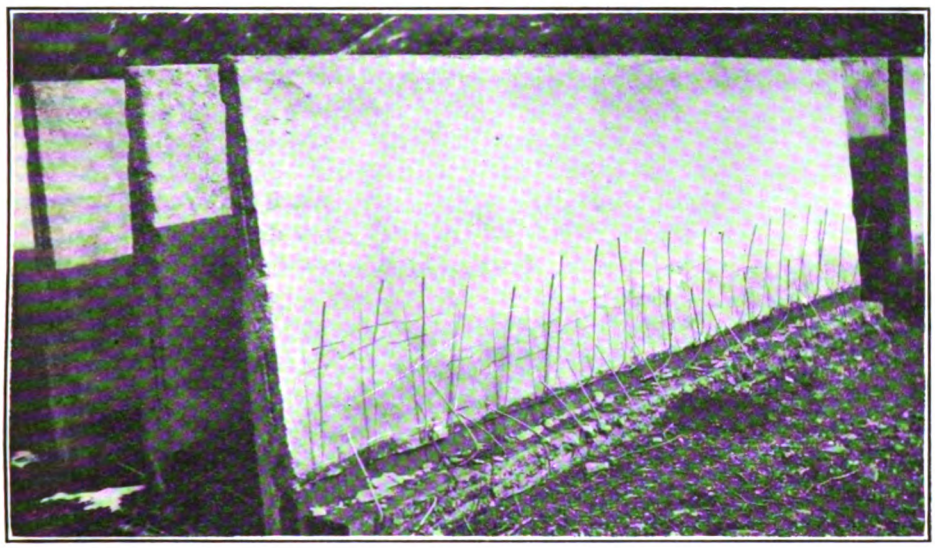
In June 1910 I was sent to the Kaweah river watersheds to make the surveys for the final location of the conduit line for what was known as the Sequoia No. 3 power project. This project, except for the power-house and a short length of pressure pipe-line, lay within the Sequoia National park. It was proposed to divert water from only the Middle fork of the Kaweah river, about eight miles above its junction with the Marble fork. As there is no feasible storage on this branch of the Kaweah, this scheme depended entirely on the natural flow of the stream for its water supply. This flow had been known to drop to 10 or 12 sec-ft. in dry years. The conduit line was nearly 12 miles long over very rough country and was practically inaccessible, except by means of a road to be constructed to its diversion point. The pipe-line was nearly a mile long and the gross head nearly 2000 ft. It was proposed to install some 3000 hp. in machinery equipment.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

A two weeks trip into the watersheds of the Middle and the Marble forks resulted in the location of two very fair reservoir sites in the watershed of the latter. Accordingly a scheme, including these two reservoirs, was recommended to take the place of the old Sequoia No. 3 project. Surveys were made. Applications for rights of way were made to the Department of the Interior. They were granted and the old Sequoia No. 3 was abandoned. This new scheme included, besides the two reservoirs, two power plants, Kaweah No. 3, with a head of 780 ft., and Kaweah No. 5, with a head of 1350 ft., the latter being situated upstream from No. 3. The combined flow of both the Middle and the Marble forks augmented by these two reservoirs was to be used, and the ultimate development calls for the installation of some 30,000 hp. of machinery equipment, 12,000 hp. in No. 3, and 18,000 hp. in No. 5.

The power-house for No. 5 was to be placed on the east side of the Marble fork about one-half mile above its junction with the Middle fork. Since No. 3 was to take the tail waters from No. 5, and since the ultimate development called for a steady flow of 100 sec.-ft., the conduit line for No. 3 was constructed to have a capacity of 175 sec.-ft. in order to take care of the excess water due to load fluctuations in No. 5.

Construction work on Kaweah No. 3 was begun toward the end of 1911. Its conduit runs some 4000 ft. along the east side of the Marble fork from the site of power-house No. 5, then across the Middle fork by means of an inverted siphon nearly 1200 ft. long. From thence it runs along the east side of the Middle fork some 18,000 ft. to the head of the pressure pipe-line. This 22,000 ft. of conduit line will afterward be referred to as the main conduit line. It was constructed to carry water at a depth of 3 ft. 6 in. with a cross-section below the water-line of 33½ sq. ft. and was all built on a grade of 1 in 1000. Since No. 5 will probably not be built for some time, a smaller con-



CONCRETE SLABS FOR BENCH CONSTRUCTION.

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

duit line consisting of a concrete flume 3 by 6 ft. inside measurement was run on a grade of 2 in 1000 up the south side of the Middle fork some 3600 ft. from the end of the siphon to a diversion point.

In view of the fine showing made on the Tule river job with a concrete-lined ditch, and the satisfactory construction and test of the sample concrete flume sections, it was decided to make the conduit line of No. 3 an all-concrete conduit. The main conduit was to consist of three types: a trapezoidal section ditch 6 ft. wide on the bottom, 4 ft. deep, with sides sloping 1 on 1 to be put in where the character of the country permitted and where excavation was easy; bench construction, using slabs for the down-hill side of the conduit, and bench construction, using slabs for both sides of conduit. Thirty-six hundred feet of conduit up the Middle fork from the siphon was to be concrete flume. It was decided to build the entire project of concrete and steel, the diversion dams, conduit line, and power-house to be of concrete, the inverted siphon and the pressure pipe of riveted steel. There is no timber construction on the job other than the cottages for the operators.

This called for the preparation and transportation of some 7000 cu. yd. of concrete material. A No. 5 Gates gyratory rock-crusher with elevator and bins was secured for crushing the rock, and a Ransome concrete-mixer for making the concrete. Hoists, cable, rails, and ties, a small locomotive, and several cars of both the flat and box type were secured for transporting material. A small steam-shovel and a steam-driven air-compressor with the necessary auxiliaries were secured. The steam-shovel did not prove to be a great success for this type of work, chiefly due to the difficulty of providing it with water and fuel. Fully one-third of all the excavation was in hard rock, and the work could hardly have been carried on without the air-compressor. In all, some $50,000 was spent for the construction plant and small tools. Of this amount, about one-sixth represented the cost of the crusher and the concrete-mixer, one-sixth the hoisting equipment, one-fourth the cars, track, etc., used in transportation, while the remaining five-twelfths represented the approximate cost of machinery and small tools used in the excavation. In other words, nearly one-half of the total plant equipment was used for excavation.

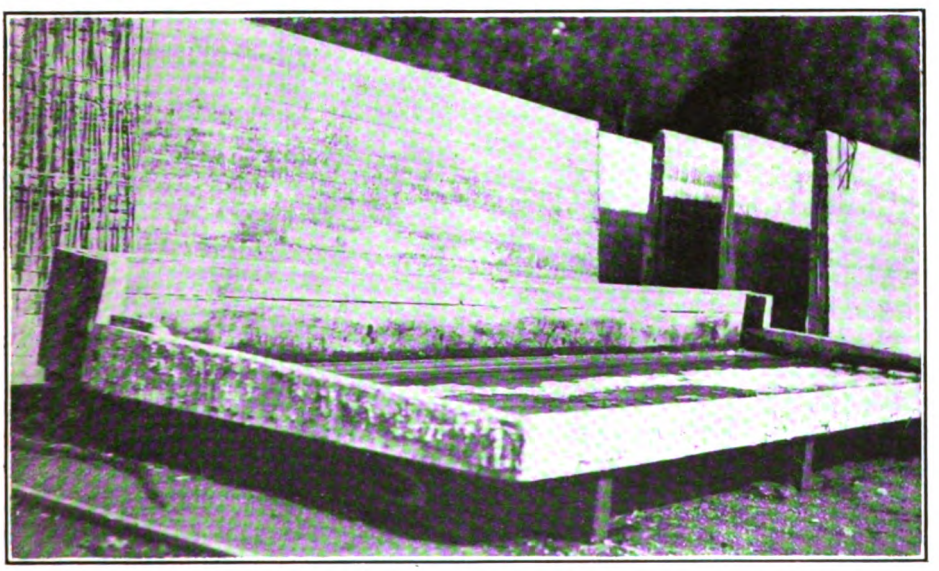
The excavation would have been greatly handicapped without hoisting and railroad equipment, so that it does not seem unfair to charge the excavation with one-half of the total plant charge. Assuming, then, that the plant at the end of the job is worth one-half what it was at the beginning, the total plant charge against the excavation of 22,000 ft. of conduit on No. 3 would be nearly $12,500, or practically 50c. per lineal foot of conduit. The labor cost of excavating was nearly $2 per foot, and the powder and other materials 50c. per foot more, so that the total field cost of excavation of the conduit line was nearly $3 per lineal foot.

At the mouth of the Marble fork the canyon widens so that there is an area at this point practically 1000 or 1200 ft. square which is comparatively level. Though none of this area is flat and smooth, it was the only available place for a yard. The line for the rest of the conduit is along the river in a deep and narrow canyon. Accordingly, a camp was made at this point, the rock-crusher with its elevator and bins set up, a yard of practically one acre smoothed for use in manufacturing shapes. I say smoothed, for the sur-

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

face of the ground was underlain with large river boulders, and it would not have been practical to disturb them. The yard sloped to the south on a grade of about 4 or 5%. The main hoist was set first to hoist material up an incline railroad across the Middle fork with a landing at the down-stream end of the siphon. The haul was about 1400 ft. long, and its total lift about 150 ft. Enough material for 18,000 ft. of the main conduit line and 3600 ft. of flume was carried up this inclined railroad. Provision was made so that by turning the hoist through 180° and moving it about 150 ft., material could

YARD WHERE 2500 SLABS WERE MADE AND CURED.



FORMS FOR CONCRETE FLUME SLAB.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

be carried up another inclined railroad of about the same length for finishing the 4000 ft. of main conduit line along the east side of the Marble fork.

The rock-crusher was set up against a cliff and at such an elevation that loaded cars of crushed rock would run by gravity to the main hoist, and empty cars to the quarry pit. A small steam-hoist was used to pull up empty cars from the main hoist, also loaded cars from the quarry pit. This whole flat around the mouth of the Marble fork was found to be underlain with practically an inexhaustible supply of sand and gravel. There were two difficulties encountered in getting this material. All of it was overtopped with some 2 ft. of loam, and the deposit was full of large river boulders which had to be broken and removed. The mix used throughout was about 1 of sand to 2 of rock, and the quarry pit furnished this proportion with a very fair degree of regularity. The material was elevated and separated into sand and rock, all rock not passing through a 2-in. screen being returned to the crusher. The material also was of the best, the sand clean and sharp, and the granite river boulders, 'niggerheads,' when broken, being the very best of material. The average labor cost of putting 2500 cu. yd. of this material through the crusher was $1.20 per cubic yard. The most expensive week's run was $2.50 per cubic yard, the least expensive 65c. per cubic yard. During a run of four weeks in December 1912, the average cost of putting 520 cu. yd. of material through the crusher was 78c. per cubic yard. To this average labor cost of $1.20 per cubic yard should be added a plant charge of about 80c. per cubic yard. The crusher and mixer cost about $8000, one-half of which should be charged against 5000 cu. yd. of material. This makes, then, the total field cost of putting 5000 cu. yd. of material through the crusher $2 per cubic yard.

The side slabs, both for the bench construction and for the flume, were made 12 ft. long, 3 in. thick at the top, and 5 in. thick at the bottom, with the lip of the L 4 in. thick and 7 in. long. The slabs for the bench construction were 4 ft. 3 in. wide, and for flume 3 ft. 8 in. wide. The forms were very simple, merely a platform consisting of 1 by 12-in. rough boards, or preferably 1½ by 8-in. boards tongue and grooved and surfaced on one side. These boards were held in place by pieces of rough 3 by 6-in. or preferably 4 by 6-in. timbers running across under the platform. Collars were made of 1½-in. material 3 in. wide on the back, with ends tapering from 3 to 5 in. wide. The ends were fastened with hinges to the 3-in. piece on the back and were provided with hasps for fastening to a 2 by 12-in. piece in the front. Four inches in front of the 2 by 12-in. was a 4 by 6-in. timber extending the length of the form, supported at the ends and held away from the 2 by 12-in. by spacers at the ends. This served to make the form for the lip of the L. When the concrete was poured it was necessary to fasten these pieces together at short intervals, usually by tacking on light cleats to keep them from spreading. A carpenter could build two of these in a day, and a form is good for making 15 to 20 slabs. The most troublesome form work was due to the unevenness and slope of the yard, it being necessary carefully to level and block up each form before the concrete was poured, in order to avoid having a warped shape. After the platform was leveled, it was the work of but a moment to place the collar in position. Nothing then remained to be done but to pour the concrete into a great flat receptacle

Generated on 2024-09-30 00:16 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

and do the necessary smoothing—a rapid and simple task. Instructions were given that the forms should be heavily coated with crude oil before the concrete was poured. These instructions were for a long time ignored and soap was used. Soap was good until the forms became old and more or less worn. If the soap was used on old forms, the slabs came out with large patches broken out of their backs. Crude oil, even with old and worn forms, insured a good smooth concrete shape. The only objection ever raised against crude oil was that it more or less discolored the slabs.*

Manufacture of Gasoline From Natural Gas

By CHARLES T. HUTCHINSON

GASOLINE as a by-product from the refining of crude oils has ceased to be merely incidental and is fast becoming a matter of first importance. Thirty years ago gasoline brought two cents per gallon at the refinery, while vast quantities were burned in the open air to make storage room for kerosene and other distillates. It is unnecessary to discuss the causes that have led up to the enormous increase in consumption. The effect of the ever-increasing shortage is shown by consequent increase in prices and the problem now before scientists and engineers is to provide adequate means of relief. There are two possible solutions upon which attention is now focusing. The first is to provide a substitute for gasoline that will perform the same functions equally well, and the second is to increase the production of gasoline. There are possibilities in the first direction in connection with by-product coking of coal as has been proved in Europe, but it is with the second possibility that this article will deal. It is well known that the Pennsylvania oils have a paraffin base and yield a much larger percentage of refined product than the California oils, which practically all have an asphalt base. Fig. 1 shows

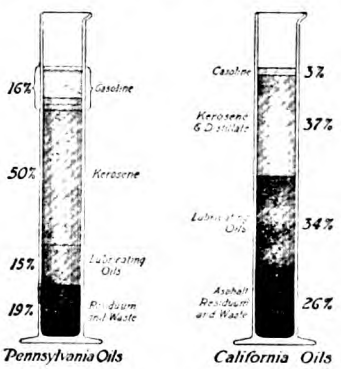


FIG. 1.

that while average Pennsylvania oils yield 16% of gasoline in refining, California oils yield only 3%. It is obvious that nothing short of new discoveries of light oil will help the gasoline production as far as its extraction from oil is concerned, and therefore attention is being turned in other directions for a means of relieving the situation.

It is doubtful when the idea of pro-

*To be concluded in the June number.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ducing gasoline from natural gas originated. It has long been known that during cold weather a liquid collects in exposed pipes at many natural-gas wells. At first the matter was regarded solely as a nuisance, since drip tanks had to be installed to separate the liquid from the gas, and when a considerable quantity of the liquid accumulated in the tanks, they had to be emptied. That the liquid which thus collected in the drip tanks was gasoline was probably recognized by many persons, but for a period of several years there appears to have been no realization of the significance of the fact, and practically no attempt was made to utilize the product. Walter O. Snelling[1] says that in the Pittsburg district the Robinson Brothers appear to have been the pioneers in this development, and they made arrangements with the lessees of a number of gas wells by which they were allowed to draw off the liquid from the drip tanks and dispose of it for a part of the profit realized. After going through a series of preliminary experiments, it was found possible to prepare gasoline of excellent quality by simply compressing the natural gas in an ordinary air-compressor and then passing the compressed gas through cooling coils connected to a suitable drip tank from which the separated gas could be drained off. Even with compression and cooling, it is not possible to produce gasoline from natural gas which comes from the earth under high rock pressure, as such gas consists almost entirely of methane, and the natural pressure which exists in the earth has been sufficient to prevent its carrying any considerable amount of the heavier hydrocarbons.

G. N. Cross[2] gives the following analysis of natural gas from the California oilfields. Mr. Cross states that the peculiar feature of the California gases is the unaccountably high percentage of carbon dioxide present. The fact that California oils are of an asphaltic base may be in some way responsible for the large percentage of carbon dioxide. He states that, roughly, the straight-line law connecting the calorific value and specific gravity holds for these gases, but the slope of the line (Fig. 2), which is shown in

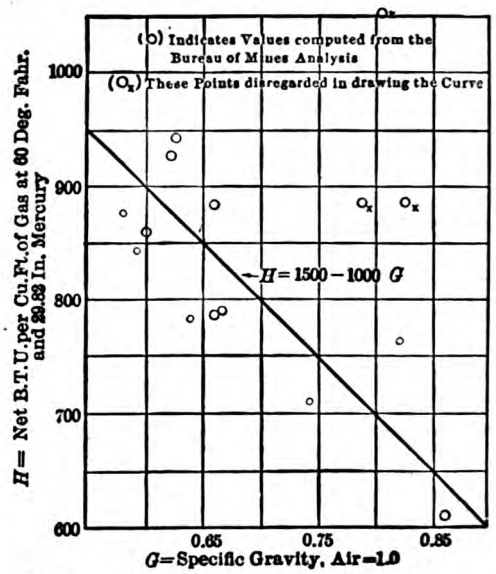

(O) Indicates Values computed from the Bureau of Mines Analysis
(Ox) These Points disregarded in drawing the Curve
H = Net B.T.U. per Cu.Ft. of Gas at 60 Deg. Fahr. and 29.89 In. Mercury
1000
900
800
700
600
H = 1500 − 1000 G
0.65
0.75
0.85
G = Specific Gravity, Air = 1.0

FIG. 2. RELATION OF CALORIFIC VALUE AND SPECIFIC GRAVITY FOR CALIFORNIA GASES.

the diagram, is reversed. This is due to the presence of carbon dioxide in large proportions.

In a discussion of liquefied products from natural gas, Irving C. Allen and George A. Burrell[3] state that up to the last two years the general practice in the manufacture of liquid natural gas was to make the product by compression of the gas in single-stage com-

[1] *Western Engineering*, September 1912.
[2] *Western Engineering*, October 1912.
[3] Technical Paper No. 10, U. S. Bureau of Mines.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ANALYSES OF NATURAL GAS FROM THE CALIFORNIA OILFIELDS. PER CENT BY VOLUME REDUCED TO 60 AND 29.82 IN. MERCURY.

Location. Year	O_2	CO_2	(C_2H_4) (C_2H_6)	CH_4	N_2	Lower B.t.u. Junker Calorimeter.	Lower B.t.u. by Analysis	Lower B.t.u. by Equation	Specific Gravity
Coalinga No. 1....1911	...	19.20	...	79.0	1.8	667	709	754	0.7460
Coalinga No. 2....1911	1.60	3.80	...	94.4	..	776	847	903	0.5974
Sunset No. 1.....1911	...	22.80	10.7	65.9	..	670	762	678	0.8217
Sunset No. 2.....1911	0.70	7.70	...	87.5	3.6	...	785	857	0.6434
Sunset No. 3.....1911	1.30	0.60	3.10	92.3	1.7	921	877	918	0.5824
ANALYSES MADE BY BUREAU OF MINES AND PUBLISHED IN BUREAU OF MINES BULLETIN, No. 19, 1911.									
Santa Maria.....1909	0.2	15.5	20.2*	62.7	1.4	...	884	675	0.8254
Santa Maria.....1909	0.2	14.1	19.0	64.6	2.1	...	882	709	0.7910
Torry 1910	..	6.8	35.6	54.2	3.4	...	1053	695	0.8051
Coalinga 1910	..	11.1	...	88.0	0.9	...	789	836	0.6640
McKittrick 1909	..	30.4	1.0	66.2	2.4	...	610	638	0.8616
West Los Angeles.1909	0.1	1.0	2.7	91.0	5.2	...	859	902	0.5978
Sunset 1909	..	10.5	...	87.7	1.8	...	787	838	0.6619
Fullerton 1909	..	1.7	9.5	86.7	2.1	...	929	876	0.6241
Fullerton 1909	..	1.4	10.9	85.8	1.9	...	944	873	0.6271
Kern River.....1909	..	6.5	8.0	84.3	1.2	...	884	841	0.6594

*The remainder of this column C_2H_6 only.

There was a trace of H_2 in Sunset No. 2, and of H_2S in Coalinga No. 1 and Sunset No. 1.

pressors operated at a pressure of 150 to 300 lb. per square inch. The one product thus obtained, so-called 'natural gasoline,' was run into a tank and 'weathered.' The weathering consisted in allowing the lighter portions to volatilize spontaneously and escape into the open air until such time as the boiling away of the liquid had practically ceased. Thus the process involved a loss of 25 to 50%, or even more. This loss was an absolute waste, not only of power and of cost of operating the engines and compressors, but of the product itself.

The next step in the industry was to pass the waste gases (of which only the small quantity used for power had been utilized) from the single-stage compressor through a higher-stage compressor, thereby getting a second and more volatile product —a 'wilder' liquid—which was run back into the first tank and mixed with the first or heavier condensate. This mixture was then again weathered to a safe degree, whereby it lost the greater part of the more volatile product that had been condensed in the second stage. Recently the process has been improved another step, in that the first-stage compressor product is run into one tank and handled as ordinary gasoline; the second stage compressor-product is run into a second tank and handled as a lighter gasoline, with which the heavy refinery naphthas can be enriched or enlivened.

The last-mentioned method of using the second-stage compressor product should receive wide recognition, and a market for the product should de-

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

velop that would be no mean factor in the industry. Blending in the proportions of, say, 1 part of the product to 4 or 5 parts of the refinery naphthas makes these heavy naphthas more volatile and of greater value as fuel for automobiles; it also greatly increases their general usefulness. The proportions to be used in blending, however, must be determined more definitely by test.

The natural gas of this country frequently contains light products that do not condense in the second-stage compressor, and for which it is practicable and necessary to use three-stage, four-stage, and even a greater stage compressors. These light products—true gases at ordinary temperatures and pressures—can be compressed and liquefied, but the liquid gases so obtained must be handled as gases and not as oils. The mistake heretofore made in the 'natural-gas gasoline' industry, as some have recognized, has been the attempt to handle the light gaseous products as oils and not as gases.

Until all the manufacturers of this lightest or three or four-stage compressor product recognize its gaseous nature, the absolute necessity for insuring the safety of the public involves certain restrictions in its transportation, and not until the realization that this extremely volatile liquid should be handled only in strong steel containers capable of withstanding high pressures, will it be transported with safety.

The vapors accompanying natural gas are clean and are ready for compression. They are analogous to the manufactured products, but have the great advantage over the latter of being ready. However, they are at present in a great measure lost to the industries. The vapors should be compressed, as previously stated, but instead of being run into an open tank, or into a closed tank and weathered from it with a corresponding loss, they should be run into steel containers and held there under compression. Such containers, capable of withstanding 3000 lb. pressure, may be procured from several firms. They may be transported to wherever gas of high heating or illuminating power is required. Liquefied gases of all kinds, such as carbon dioxide, hydrogen, and acetylene, have been handled successfully in such containers for a number of years.

Some of the products of natural gas, which are now going to waste, could be compressed into containers and could be handled as gases. The process has been developed for other gas industries, but its promise as a profitable commercial enterprise in connection with the development of the new product has only recently been recognized.

The multiple-stage compressor may be used for obtaining a number of products, or the single-stage compressor may be used for obtaining one product; then, by allowing this 'wild' product to escape from a common container into a second, a third, and a fourth container, under partial pressure, it may be separated or fractionated into a second, a third, and a fourth product. This compression and later separation or fractionation of a common 'wild' product into several products is, however, a waste of power, as ordinarily the gas should be compressed through a multiplicity of stages directly into its several products. It is doubtful whether these waste products from gasoline manufacture could be made commercially profitable on the Pacific Coast, as the wonderful development of hydro-electric power has brought cheap electric lighting even to the most remote rural districts.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

C. F. Hirshfeld[1] has furnished a diagrammatic representation of the method of treatment, reproduced in Fig. 3. In this, *a* is compressor, *b* a cooler or condenser, *c* a separator, *d* a trap, and *e* a pressure-regulating valve. In operation, gas is compressed in *a*, cooled at practically constant pressure as it

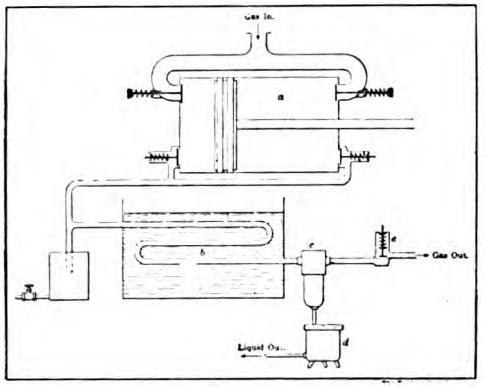


FIG. 3. DIAGRAMMATIC REPRESENTATION OF COMPRESSOR.

passes through *b*, and the liquid gasoline which unites is separated at *c*, from which it drains into a trap *d*. With a few minor modifications, this is the plan that has been followed thus far in such work as has been done in California. One plant now in operation has a capacity of about 700,000 cu. ft. of gas per day of 24 hours, and includes the following:

One two-stage direct gas-engine driven compressor, in which each stage operates independent of the other. Engine cylinder, 16-in. diam.; high-pressure gas cylinder, 7¼-in. diam; low-pressure gas cylinder, 14-in. diam.; stroke, 20 in.; indicated horse-power, 80, at 180 revolutions per minute.

One inter-cooler, consisting of seven coils of 3-in. pipe with return bends, each coil 39 ft. long.

One after-cooler, consisting of 14 coils of 3-in. pipe; otherwise the same as inter-cooler.

One small receiving tank which acts as a collector for the condensed gasoline.

It will be noted that the high and low-pressure compressors are driven independent of one another. This is a desirable feature on account of the variable pressure at which gas is discharged from the well. Gas after passing through a scrubber is admitted to the low-pressure compressor at or near atmospheric pressure, the temperature ranging between 60 and 65°F. It is compressed to about 50 lb. and a temperature of 190°F., at which it is discharged into the inter-cooler. During its passage through the inter-cooler it is reduced to 45 lb. pressure and a temperature of 80°F., at which point it is taken into the high-pressure cylinder and compressed to 250 lb., the final temperature being 190°F. It then enters the after-cooler, in which the temperature of the gases is reduced to 60°F., the gasoline condensed, collected in the receiver, and drawn off at intervals. Both the inter-cooler and after-cooler are arranged somewhat in the order of a cooling tower, and a spray of water is kept in circulation by means of a small pump, from the top of the coolers to a trough beneath, with baffles arranged to give the maximum cooling effect. An induction cooler is sometimes used for the final stage in the cooling process before the gasoline is discharged into the receiver. This consists merely of a smaller pipe inside of a larger one. A small amount of gas is permitted to expand inside of the annular space between the larger and smaller pipes, while the compressed gas, after passing through the after-cooler, is flowing through the smaller.

[1] *Western Engineering*, October 1912.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The smaller pipe is generally two inches in diameter and the larger five inches.

Another typical installation having a rated capacity of 250,000 cu. ft. of gas per day of 24 hours, includes a 14¼ by 6¼ by 12-in. belt-driven two-stage compressor, driven from a natural-gas engine. The inter-cooler is the same type as employed in an ordinary air-compressor, while the after-cooling is accomplished in two stages, the first including 480 ft. of 2-in. pipe made up in a coil with return bend connections and exposed to the air for cooling, and the second of 160 ft. of 2-in. pipe inside of 6-in. casing, the cooling being accomplished by expanding gas within the annular space as described above, connection being made to the expansion valve at the top of the receiver. Practically all the commercially recoverable gasoline is condensed at 50°F. This second plant presents the advantage of requiring no water for cooling, which is quite a desirable feature, as water in the oilfields is scarce and of poor quality. Another desirable feature is the method of driving. The gas-engine is away from the gas-compressor and in a separate room. This does away with the chance for possible explosions that might be caused by compressed gas leaking through the compressor stuffing-boxes and coming in contact with the sparking device on the gas-engine.

In using a standard air-compressor for compressing gas, lubrication troubles are frequent. The gas seems to have a faculty for absorbing the lubricant, which is shown by the frequent scoring of the piston rods. Metallic packing for the stuffing-boxes is to be preferred to the ordinary packing, as it seems to withstand the pressure better and allows less leakage of compressed gas. Mechanical inlet-valves are not so satisfactory as the poppet type, on account of the difficulty in keeping them properly lubricated. Poppet valves should be of the cup type rather than the mushroom type, on account of the frequent breakage of stems which allows the valve to fall into the cylinder and wreck the compressor. Cages around the valve to prevent this occurring diminishes the volumetric efficiency of the compressor and should not be necessary if the valve is properly designed and constructed.

With regard to the power required to compress gas, Thomas R. Weymouth[5] says that the use of the theoretical formula for adiabatic compression may lead to serious errors. After conducting a great many tests of gas compression, the chart, Fig. 4, was prepared from two independent tests.

Curve *I* represents the theoretical isothermal, curve *A* the theoretical adiabatic, while curve *C* is the curve plotted according to Mr. Weymouth's empirical formula, which he has developed as follows:

W = foot-pounds of work per pound of gas compressed

P_1 = absolute suction pressure lb. per sq. ft.

P_2 = absolute discharge pressure lb. per sq. ft.

V_1 = volume of 1 lb. of gas at pressure P_1 cu. ft.

Theoretical work required for isothermal compression

$$W = P_1 V_1 \log_e \frac{P_2}{P_1}$$

P_0 = absolute pressure in lb. per sq. ft. on which the measurement is based

T'_0 = absolute temperature-basis of measurement in degrees F.

[5] *Journal* American Society Mechanical Engineers, May 1912.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

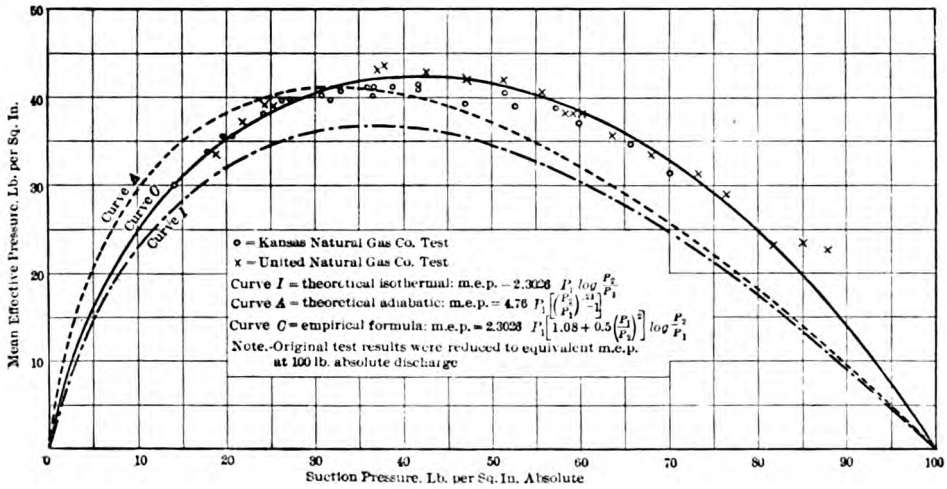

Mean Effective Pressure, Lb. per Sq. In.
Suction Pressure, Lb. per Sq. In. Absolute
Curve A
Curve C
Curve I
o = Kansas Natural Gas Co. Test
x = United Natural Gas Co. Test
Curve I = theoretical isothermal: m.e.p. = 2.3026 $P_1 \log \frac{P_2}{P_1}$
Curve A = theoretical adiabatic: m.e.p. = 4.76 $P_1\left[\left(\frac{P_2}{P_1}\right)^{.21}-1\right]$
Curve C = empirical formula: m.e.p. = 2.3026 $P_1\left[1.08+0.5\left(\frac{P_1}{P_2}\right)^2\right]\log\frac{P_2}{P_1}$
Note.-Original test results were reduced to equivalent m.e.p. at 100 lb. absolute discharge

FIG. 4.

V_0 = volume of 1 lb. of gas at P_0 and T_0

T_1 = absolute temperature at which the gas is compressed.

If the compression were performed strictly according to the adiabatic law where n is the ratio of specific heats of the gas at constant pressure and volume, the work, neglecting clearance, required for 1 lb. of gas would be theoretically:

$$W = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

The bases generally adopted throughout the gas country are:

$P_0 = 14.65$ lb. per sq. in.

$T_0 = 60 + 460 = 520°$F.

$n = 1.266$ for average natural gas

Substituting these values, formula for isothermal compression becomes:

$$HP_1 = 102.23 \log \frac{P_2}{P_1}$$

and for adiabatic compression

$$HP_0 = 211.27 \left[\left(\frac{P_2}{P_1}\right)^{0.21} - 1\right]$$

For isothermal compression the mean effective pressure in pounds per square inch

$$m.e.p_1 = 2.3026 p_1 \log \frac{P_2}{P_1}$$

For adiabatic compression it is

$$m.e.p_0 = \frac{n}{n-1} p_1 \left[\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} - 1\right]$$

which for natural gas where $n = 1.266$ is

$$m.e.p_0 = 4.76 p_1 \left[\left(\frac{p_2}{p_1}\right)^{0.21} - 1\right]$$

A study of the plotted observations of the tests in comparison with the two theoretical curves A and I reveals the fact that the actual curve obtained in practice resembles the isothermal more nearly than it does the adiabatic, and that it diverges from the isothermal at a comparatively uniform rate as the suction pressure increases and can be fairly represented by the equation

$$m.e.p. = 2.3 p_1 \left[1.08 + 0.5\left(\frac{p_1}{p_2}\right)^2\right] \log \frac{p_2}{p_1}$$

which is plotted as curve C in Fig. 4.

It must be remembered that all natural gas is not suitable for the manufacture of gasoline. Chemical analysis cannot determine the possibility of commercial success of such projects. There is one way, and one way only, for testing, and that is merely to erect a small-scale compressing and condensing plant at the source of gas supply and run it for a period long enough to

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

determine the commercial feasibility of the project. Such a testing plant may be portable and may be hauled from well to well. It would return its first cost in a short time. The possibilities in the California oilfields of providing gasoline from gas are just commencing to attract attention. A few plants are already in operation and have been so successful that there is no doubt that the coming year will see the production of gasoline from natural gas become an integral part of the California oil industry.

Concrete Pavement by Day Labor at Chehalis, Washington

By F. O. BLAIR *

ON account of the heavy, wet, gumbo soil, street improvements of a permanent character are little short of a necessity in this city, yet property values are not high enough to warrant a fancy priced pavement without confiscating the property. To meet this condition, concrete pavement was recommended to, and adopted by, the City Commission and, which has proved to be, even beyond expectations, satisfactory in every respect.

The Commission also decided that it would purchase the necessary equipment and do its own work under the supervision of an engineer, believing that if handled on a business basis, the cost could be greatly reduced as well as more satisfactory results obtained. The Commission appointed its city engineer and the work was placed in his hands for execution.

The organization consisted of the city engineer, 1 assistant engineer, 2 chainmen when needed, 1 general foreman, 1 sub-foreman, 1 grading foreman, and the requisite number of laborers, and teams. The districts improved required 20,000 cu. yd. of grading in excavation. This grading was started by the general foreman, but as soon as it was far enough advanced to permit of other work, was turned over to, and carried to completion by the grading foreman. The general foreman then proceeded with the construction of the drainage, curb, and sub-grade, and the distribution of materials for the pavement. When this work was far enough advanced, the paving was started and placed in charge of the sub-foreman, the general foreman exercising a general supervision, in conjunction with the continuance of his own work.

By handling the work in this manner, there was no fluctuation in the organization, and a maximum efficiency was obtained by reason of the increased skill that naturally results from the same man doing the same class of work continuously, and from intelligent supervision by which the incompetent men were eliminated. The employment and discharge of men was entirely in the hands of the city engineer and his foreman, and placed on a merit basis, absolutely free from the political or

*Engineer, Chehalis, Washington.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

other influences that usually prevail in municipal work.

The city's equipment consists of a 7-wheeler grading outfit, 2 plows, 4 slips, 1 road grader, 1 road roller, 4 dump wagons, 1 concrete mixer, and the usual complement of wheelbarrows, shovels, small tools, etc. The total investment, including maintenance and interest to January 1913 was $5533, which was paid out of the current expense fund. To this amount, for the season's work, was credited $1436, or 5% of the actual cost of material and labor entering into the work in which the equipment was used. This takes into account the increasing cost of maintenance, and the cost of replacement of small tools that the city will pay out on its investment in from four to five years, doing the same amount of work each year that was completed last season. Should the city desire to discontinue its present policy, the equipment is maintained in such condition that it could be readily sold in the open market for the balance of its indebtedness. This places the investment on a safe and sound basis so far as the city as a whole is concerned, and gives to the improvement districts the economic advantages of first-class modern equipment as well as eliminating the cost of transporting equipment in and out of the city, that would necessarily be added to the cost of contract work.

Bond buyers are invited to look over the districts and bid for the bonds, the succesful bidder entering into a contract to take the bonds on the completion of the work. With this security, the local banks furnished the necessary money to carry on the work. All labor and materials were paid for by vouchers issued against the respective districts in which the labor was performed or the material used. These vouchers, properly endorsed and sworn to as provided by law and city ordinance were then honored by the banks.

FINISHED SINGLE-COURSE CONCRETE PAVEMENT, CHEHALIS.

SPECIAL MIXING EQUIPMENT OWNED BY THE MUNICIPALITY.

On the first day of each week, all vouchers were turned in, checked up by the Commissioner of Finance, voted upon by the City Commission, and taken up by warrants issued against the corresponding districts. These warrants were held by the banks until the districts were closed. On closing the districts, the warrants were redeemed in their order with cash, according to the amount of money collected from the district, and the balance with the money from the sale of the bonds issued against the district covering the unpaid portion.

Materials were purchased in the open

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

market wherever the best could be bought for the least money. Bills were paid promptly on the first of each month and advantage taken of all cash discounts. By adhering strictly to this golden rule of business, the city enjoyed a certain prestige in getting its materials at the right price and getting prompt shipments, the latter being a big factor of economy in being able to keep the stock limit down with no hindrance to the work.

The system of accounts in use by the city was designed for two purposes: First to show a complete record of the material used and labor performed, and second to show the unit cost of all material in place and work completed. In a few minutes time, at the close of each day's work, unit costs can be determined with accuracy, and while fresh in mind, the conditions that have made the costs higher or lower than they should be can be studied. By a careful comparison of these costs from day to day, considerable economy can be effected by changes in or improvement of methods, the handling of material and various other ways that present themselves, and effective measures taken before it is too late.

The specifications adopted were for a singe-course pavement, 6 in. thick, of a 1:2:4 mix. Washington portland cement was used, clean, coarse, washed sand, and crushed trap rock uniformly graded from ¼ to 1¼ in. One-quarter inch expansion joints were placed every 25 ft. A two-bag Chicago-Cube special paving mixer was used. With the above mix, the machines easily handled a three-bag batch, laying 3 sq. yd. with each batch. In depositing and spreading the concrete, special care was exercised to prevent separation. Just sufficient water was used to form a plastic mass and still keep the particles of crushed rock in the surface. Any spots showing indications of being honeycombed or not uniform, were dug out and refilled immediately. After spreading, striking off with a templet, the surface was lightly tamped and smoothed with the back of a shovel. When just beginning to take the initial set, the surface was again smoothed with a wooden float, the edges rounded up, and the surface broomed. All finishing was done from a plankway suspended over the pavement and no walking upon or disturbing the surface was allowed until thoroughly set. The pavement was kept well sprinkled with water for seven days and closed to traffic for three weeks.

The average cost of materials on the job was: sand, $1.55 per cu. yd.; crushed rock, $1.60 per cu. yd.; cement, $2.25 per bbl. The labor cost ranged from 30c. per hour for common labor to 50c. per hour for skilled finishers. The average cost of all pavement laid, including materials, labor, strip setting, expansion joints, water, and 5% for the use of equipment was $1.05 per sq. yd. It has solved the problem in this city.

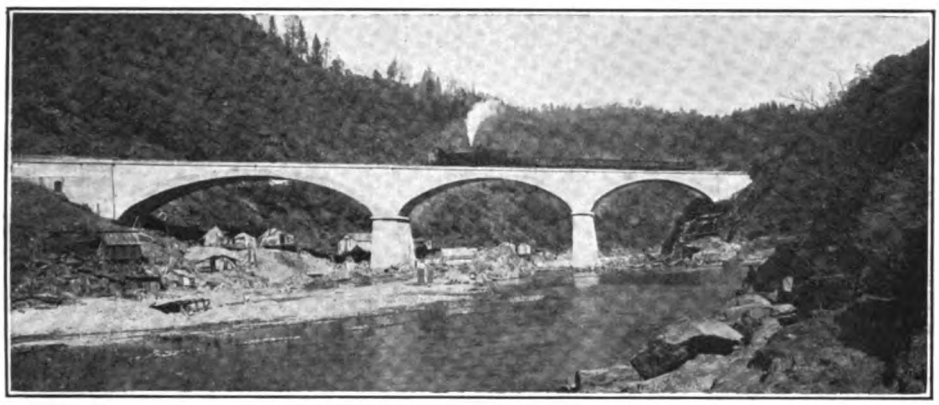
Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

A Reinforced Concrete Railroad Bridge

By W. P. DAY*

REINFORCED concrete in bridge construction has received marked approval in the state of California during the past few years, and is recognized by both the engineer and the layman today as a desirable structure both from the standpoint of permanence and economy. Concrete bridges in this state were first used for county highway purposes, supplanting the old combination bridges of wood and steel. The marked success that followed the use of concrete by the counties led progressive corporations, operating interurban cars, to build their bridges of the same material, several such structures existing in California today. Finally, reinforced concrete came into use, in a few isolated cases, for railroad crossings, and it is the purpose of this article to give a brief description of a bridge built for this service.

The structure illustrated, built by the Mountain Quarries Co., crosses the American river a short distance from the town of Auburn, in Placer county, California, and is used to carry heavy Mallet compound-engines drawing cars heavily laden with limestone. It is composed of three skew spans, each 140 ft. in the clear. The approaches at either end are built with longitudinal walls carrying a heavy, reinforced-concrete slab. The fill and ballast of the approaches rest directly on the slab, and, with the live load, are carried by the slab to the approach walls. Owing to the steep hills on either side of the river, the line could not be properly

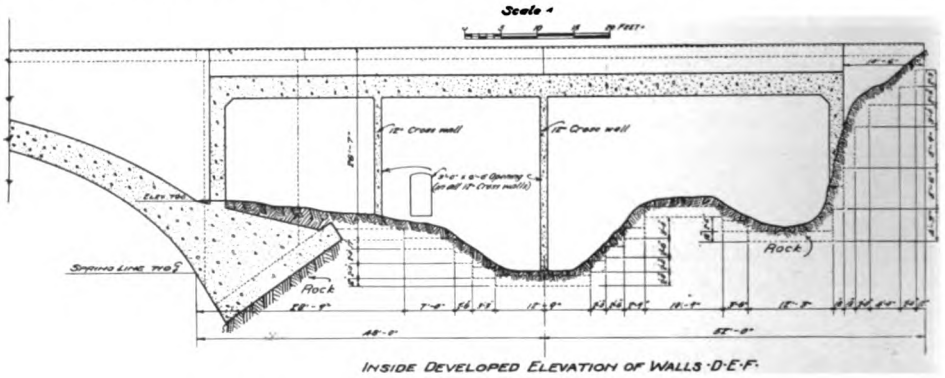


VIEW OF COMPLETED BRIDGE FROM UPSTREAM SIDE.

*Leonard & Day, Consulting Engineers, Rialto Bdg., San Francisco.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

projected without curves at either end of the bridge, although the angle of skew is 45° with the direction of the the flow of the river at the point crossed. Consequently, both approaches were laid out so as to permit of a 16° curve in the line at each end. The curve at each end begins at a point directly over the abutment, permitting the line to parallel the river in side-hill cut. The natural topography necessitated the use, in some cases, of very high approach-walls. The latter were all founded on bedrock, and the horizontal slabs at the top were firmly anchored to the rock of the hillside.



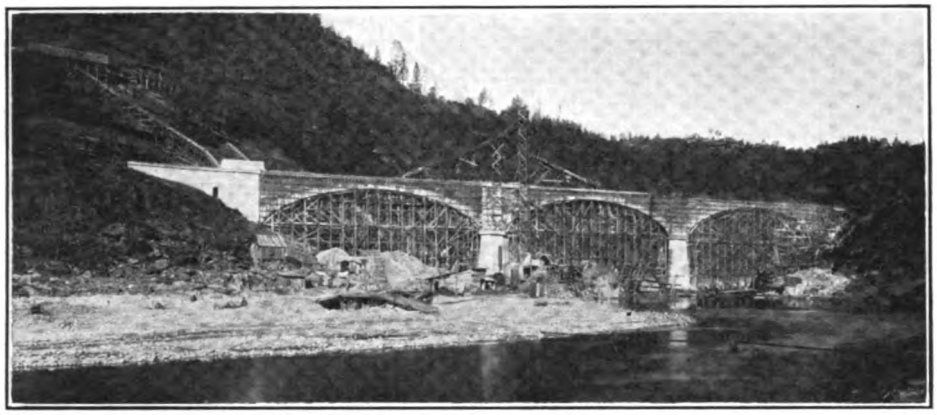
SECTION ELEVATION OF APPROACH WALLS.

All of the foundations were carried to bedrock, no particular difficulty being experienced except in the construction of pier No. 2, which necessitated additional precautions on account of its depth. At the time the structure was projected, the river was high and flowing rapidly. It was impossible to determine accurately the elevation of the rock at the middle of the stream, and the original plans did not contemplate a pier of the depth ultimately built. A concrete coffer-dam was built and sunk as the excavation progressed and proved very successful. It was rectangular in plan with walls 8 in. thick, fitted with a cutting-edge on the bottom. The spaces between the cross-brace walls were large enough to permit the use of a clam-shell bucket for removing the gravel and loose rock in the interior. As fast as the excavation progressed, and the coffer-dam settled, forms were added and the concrete walls extended. Before reaching bedrock, it became necessary to load the structure in order to facilitate its sinking, but this offered no difficulty and was successfully accomplished. After reaching bedrock, a diver went down and thoroughly cleaned the rock. It was then filled in solid with concrete and the pier proper built on it in the regular way.

The falsework was built of 8 by 8-in. posts, three to a bent, and spaced 7 ft. 6 in. apart. These were well braced longitudinally and transversely, as shown in the accompanying illustration. The spring line for the arches is about 40 ft. above the bed of the river, and the falsework required the use of considerable lumber. In order properly to form the intrados curve, 2 by 4-in. longitudinals were blocked up from the stringers to the correct line, and the lagging put on transversely. In most cases the 2 by 4s sprung to the line desired without any trouble, but near the haunches, where the curvature is sharp, they were

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

inclined to split, and two pieces of 1 by 6-in. were substituted. The latter sprung to the sharpest curve without trouble. On the outer form for each rib, a triangular strip, one inch on a side, was nailed to the line of the extrados curve. Its purpose was to make a uniform construction joint between the rib and the spandrel walls and to prevent the usual ragged, unsightly line and the efflorescence seen on many bridges. It is believed that it successfully performed the function for which it was designed. By referring to the illustration of the structure, the effect of this strip is shown as a line on the face of the spandrel wall.

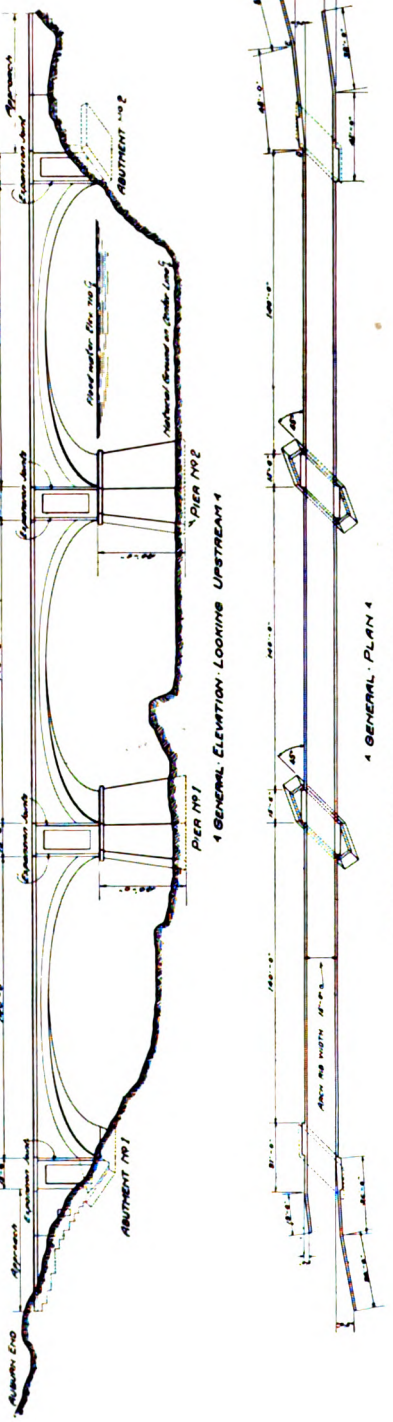


PARTLY COMPLETED BRIDGE, SHOWING FALSE WORK IN PLACE.

During the construction of the arch on the Placer side of the river, it was deemed advisable to prepare for a possible rise in the river, owing to the approach of the wet season. Falsework under the first two arches was still standing in place, and it was believed that if the falsework under the third arch could be made to withstand a heavy rise in the river and at the same time have suitable struts to take the thrust of the middle span, the carrying away of the falsework under the first two arches would be attended by no serious consequences. Therefore piles were driven under the third span, and horizontal trusses of cables and timber struts were placed in position, one at the level of the bed of the river and the second about 16 ft. above that level at the top of the piles. Both trusses were anchored to the midriver pier and to the rock on the hillside. Anchors 2-in. diameter with split ends and loop eyes were grouted into drilled holes in the pier, and the rock and cables were attached to the eyes with Crosby clips. All cables were drawn taut by the use of a Spanish windlass. In addition to these precautions for preventing the falsework from going out, all of the piles were sheathed parallel to the stream-flow to facilitate the passage of drift under the span. At the spring line of the arch, two triple lines of 8 by 12-in. timbers firmly bolted together were used as struts from the pier over to the solid rock. They were braced laterally and vertically so as to enable them to safely take a load equal to the thrust of the middle span.

All three arches are alike in design and construction, although the general view, owing to the skew, shows them variable. The rise of each is 24 ft.,

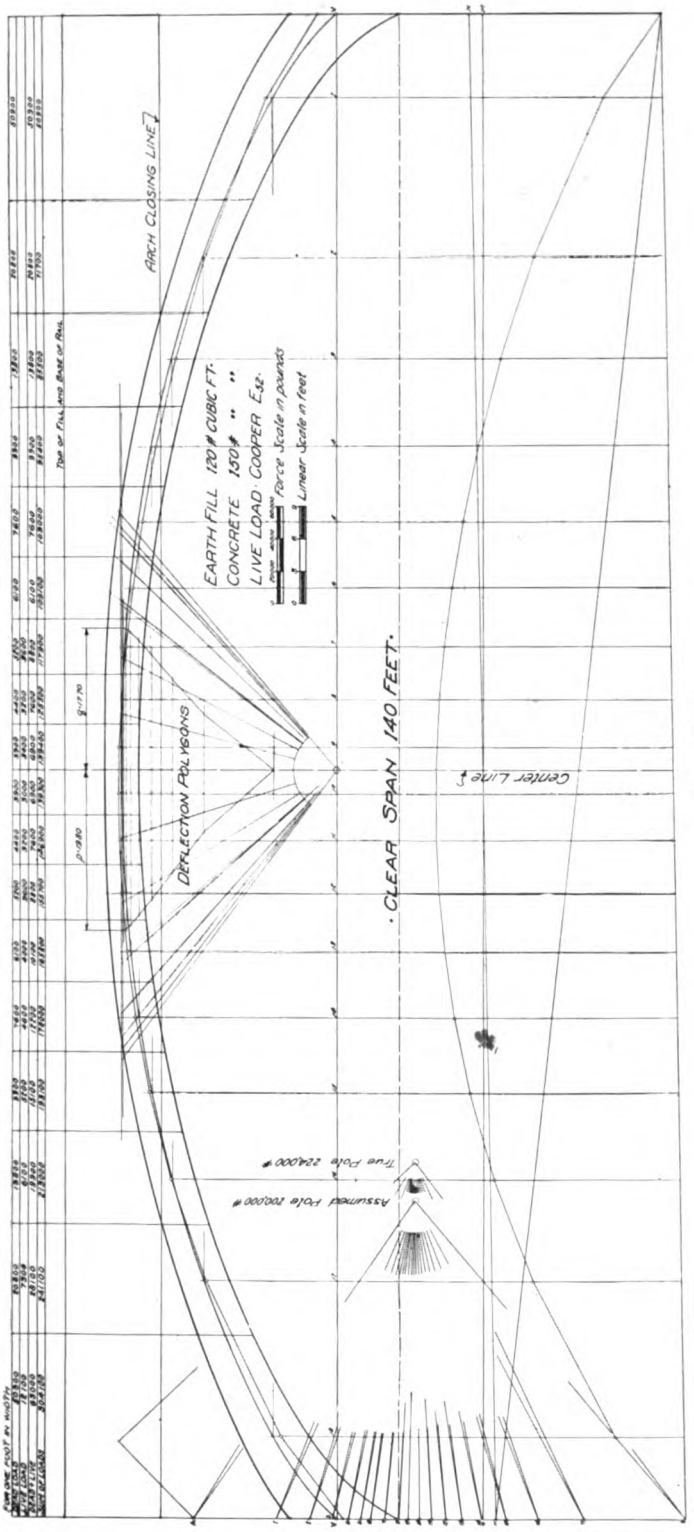
Generated on 2024-09-30 00:14 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



PLAN AND ELEVATION OF BRIDGE, LOOKING UPSTREAM.

TABULATION OF STRESSES.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



STRAIN SHEET.

Generated on 2024-09-30 00:13 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

and the crown thickness is 3 ft. 3 in. Stresses in the rib were obtained by the 'elastic' theory, and include live and dead-load stresses, rib-shortening, and temperature. The specifications for the design called for a 50,000-lb. axle load. An equivalent uniform load for a 52,000-lb. axle load was obtained and 50% added to this for impact, giving a uniform load of 650 lb. per square foot. This load was arbitrarily increased to 700 lb. per square foot. The stresses shown in the table represent the maximum possible for the following combination—the live load so placed on the span as to produce maximum bending in the rib, a rise or fall of temperature, and rib shortening. In a structure as massive and heavy as the one under discussion, it is believed that the assumed impact-effect is a good deal greater than actually occurs. Unquestionably, in steel structures, the effect of impact is considerable, the line load representing a large proportion of the total load. In the structure considered herein, the live load is but a small proportion of the total load, and the impact is absorbed, in good part, by the earth fill. Furthermore, the assumed variation in temperature will, perhaps, never exist throughout the whole rib. For the preceding reasons, it is believed logical to allow the comparatively high unit-stresses given in the table.

Inspection of the strain sheet shows that for dead and live loads, no tension exists in the rib, the thrust line being confined to the middle third throughout its length, signifying a correct choice of curve for the given rise, span, and superimposed loads. It is possible, in practically all cases, to obtain a rib in which the thrust line lies in the middle third at all points, thereby producing no tension for dead and live loads. A consideration of temperature and rib-shortening stresses usually produces tension in restricted sections near the haunches. The designers of this structure made three different ribs of the same rise and span before obtaining one in which no tension existed for dead and live loads.

Gravel for the structure was obtained from the river at the site, both by scrapers and clam-shell digging-buckets. An analysis showed it to be composed of the proper proportion of fine and coarse material, and it was used as it came from the river. Before completing the third arch, the weather became cold and all of the water used for mixing was heated, so that the concrete attained a temperature of 60°F. in place.

The Mountain Quarries Co. was undecided, in the beginning, as to whether it would build a steel or a concrete bridge, and plans for both types were prepared. When bids were received, it was found that the concrete bridge was about 20% cheaper than the steel, and the former was selected by the company. Owing to the great weight of the concrete bridge, the live load does not seriously affect it, while the steel bridge is materially changed by the heavy live-load. In other words, the steel highway bridge with wooden floor is cheaper than the concrete railway bridge, but the heavy loads produced by locomotives and cars make the concrete railroad structure cheaper than the steel railway bridge.

Generated on 2024-09-30 00:14 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Cost of Water per Acre*

UNDER the present conditions of construction, the cost per acre of water rights, or of water for irrigation in the arid region, is far higher than is usually appreciated. During earlier decades, before any considerable number of large irrigation canals had been built, it was a relatively simple and inexpensive matter for farmers to join together and build small canals that could be enlarged as the demand for water increased. All such easily available opportunities, however, have been utilized, and development has proceeded to a point where on most of the recent irrigation systems it has been necessary to provide storage, thus adding materially to the cost.

There has also been a notable increase in the cost of labor and of materials used in construction. This condition has been pointed out in various hearings before Congress, notably in the series before the Ways and Means Committee of the House of Representatives at the time of the granting of the $20,000,000 loan. It is there shown, notably in a statement submitted by Representative Mondell, that one of the arguments for increase of the reclamation fund was in the fact that common labor had advanced from the time of the preparation of the plans for works in 1903 and 1904 from 20 to 50%, and that the efficiency of such labor had fallen off in greater proportion. Costs were also affected by the increased price of materials and equipment.

The following table gives in condensed form lists of some of the recently constructed and proposed larger private projects and Carey Act projects.

These figures, obtained from printed reports of state engineers and public data, show that on over 90 modern irrigation systems being built by private or corporate capital, the cost per acre averages nearly $53. This cost does not include the annual cost for operation and maintenance.

The cost to the settler is increased by the fact that payment is made on most of these projects in instalments bearing interest at 6% or even more. The total payments made for such a water right with simple interest at 6% would be about $70.50 per acre on the basis of ten equal annual instalments of the principal as compared to $53 without interest.

COST OF PRIVATE IRRIGATION PROJECTS

Name of project or company.	Acreage in project.	Cost or water right charge per acre.[1]
Colorado:		
Amity Canal	80,000	$100[2]
Beaver Land and Irrigation Co.	20,000	175[2]
Catlin Canal	25,000	100
Colorado Coöperative Co.	5,200	60
Denver Reservoir and Irrigation Co.	200,000	45
East Palisade Irrigation District	645	63

*Prepared by the U. S. Reclamation Service.
[1]Engineers' estimates where project is proposed or incomplete.
[2]Estimated at from $75 to $150 per acre. Includes land.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Name of project or company.	Acreage in project.	Cost or water right charge per acre.[1]
Montana:		
Fort Lyon Canal	70,000	100[3]
Grand Valley Canal	40,000	60[4]
Greeley Poudre Irrigation Co.	125,000	45
Mesa County Irrigation District	2,568	73
Orchard Mesa Irrigation District	9,122	119
Otero Irrigation District	20,000	40
Palisade Irrigation District	6,000	41
Paradox Valley Irrigation Co.	30,000	45
Pueblo-Rocky Ford Irrigation Co.	100,000	150[5]
Redlands Irrigation and Power Co.	5,000	100[6]
Routt County Development Co.	39,000	45
South Palisade Heights Irrigation District	700	127
[1]Engineers' estimates where project is proposed or incomplete.		
Conrad Land and Water Co.	.....	40
Great Falls Land and Irrigation Co.	36,000	50
Nebraska:		
Belmont Canal and Irrigation District	20,000	25[7]
Tri-state Canal	60,000	42
New Mexico:		
French Land and I Co.	40,000	50
Oregon:		
Bonanza Project	20,000	39
Eagle Valley	21,700	80
Turnish	6,000	60[8]
Paradise	100,000	60
Willamette Valley	20,000	50
South Dakota:		
Red Water Irrigating Association	4,000	40
Utah:		
Provo Reservoir	12,000	80
Utah Lake Pumping	8,000	40[9]
Washington:		
Cascade Canal Co.	10,000	50
Congdon Canal Co.	4,200	121
Kennewick Canal	14,000	163
Lower Yakima I. Co.	12,500	129
Selah Moxie	7,000	86
Selah Valley Development Co.	10,000	150
Union Gap Irrigation Co.	5,000	135
Washington Irrigation Co.	50,000	46
COST OF CAREY ACT PROJECTS		
Colorado Land and Water Supply Co.	16,278	45
Two-Butte Irrigation and Reservoir Co.	22,000	35
Valley Investment Co.	24,000	60
Colorado:		
Great Northern Irrigation & Power Co.	2,121	$ 55
Colorado Realty and Security Co.	45,875	45
Toltec Canal Co.	14,853	40

[3]Estimated at $75 to $150 per acre.
[4]Per miner's inch.
[5]Includes land.
[6]Estimated at from $65 to $150 per acre.
[7]For river rights only. Purchase of Pathfinder Reservoir water will increase this to $35.
[8]Estimated at from $50 to $70 per acre.
[9]Estimated at from $40 to $50 per acre.

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Name of project or company.	Acreage in project.	Cost or water right charge per acre.[1]
Idaho:		
American Falls Canal & Power Co	57,242	40
Big Lost River Irrigation Co	78,242	40
Birch Creek Irrigation Co	20,000	50
Blackfoot North Side Irrigation Co	22,280	..
Black Canyon Irrigation District	98,492	72
Blaine County Irrigation Co	14,720	40
Boise City Carey Act Project	151,000	..
Bruneau Irrigation Co	40,000	60
Emmett Irrigation District	5,800	50
Grandview Extension Irrigation Co	1,000	65
Grassmere Irrigation Co	47,500	65
Hansen, C. V., Mackay Project	3,456	40
Hegsted, Victor, Project	3,410	40
High Line Pumping Co., Ltd	3,860	45
Houston Ditch Co., Ltd	1,884	35
Idagon Irrigation Co., Ltd	9,000	60
Idaho Irrigation Co., Ltd	130,000	50
Keating Carey Land Co	15,597	30
Kings Hill Extension Irrigation Co	9,655	65
Kings Hill Irrigation and Power Co	13,359	65
Lemhi Irrigation Co	3,500	50
Little Lost River Land & Irrigation Co	20,000	30
Marysville Canal & Improvement Co., Ltd	6,134	20
Owsley Carey Land and Irrigation Co	8,600	35
Owyhee Land and Irrigation Co	29,535	55
Owyhee Irrigation Co., Ltd	3,296	45
Pahsimerai Project	6,000	30
Portneuf-Marsh Valley Irrigation Co	11,914	35
Pratt Irrigation Co., Ltd	4,674	40
Snake River Irrigation Co., Ltd	6,500	50
Thousands Springs Land and Irrigation Co	6,300	30
Twin Falls Land and Water Co	244,000	25
Twin Falls North Side Land and Water Co	207,144	45
Twin Falls Oakley Land and Water Co	45,000	65
Twin Falls Raft River Irrigation Co	99,668	50
Twin Falls Salmon River Land & Water Co	127,707	40
West End Twin Falls Irrigation Co	46,000	50
Montana:		
Billings Land and Irrigation Co	27,000	40[10]
Big Timber Project	17,194	60
Valier Project	115,100	40
Oregon:		
Central Oregon Irrigation Co	139,204	40
Central Oregon Irrigation Co	74,198	60
Columbia Southern Co	27,000	50[11]
Deschutes Land Co	31,082	36
Deschutes Reclamation & Irrigation Co	1,280	40
Desert Land Board	27,000	..
Portland Irrigation Co	12,000	46

[10]Estimated at from $20 to $60 per acre.
[11]Estimated at from $50 to $60 per acre.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Name of project or company.	Acreage in project.	Cost or water right charge per acre.[1]
Powder Land & Irrigation Co.	65,000	100[12]
Utah:		
Mosida Pumping Plant	8,000	150[13]
Wyoming:		
Big Horn County Irrigation Co.	20,411	50
Boulder Canal	6,120	30
Burch Canal	35,887	50
Carbon County Land & Irrigation Co.	7,793	30
Cody and Salsbury Canal	77,199	..
Cody Canal	26,429	50
East Fork Irrigation Co.	4,901	30
Eden Land and Irrigation Co.	95,658	30
Elk Canal	2,724	30
Fisher Ditch	320	10
Green River Land and Irrigation Co.	75,257	35
Hammitt Canal	6,295	60
Hanover Canal	10,682	50
Hawk Springs Project	12,238	50
Hubbard Canal	38,604	40
James Lake Irrigation Co.	14,554	35
La Prele Ditch and Reservoir Co.	18,558	50
Lovell Irrigation Co.	11,320	25
McDonald Canal	15,159	50
Medicine Wheel Canal Co.	22,385	30
North Laramie Canal Co.	4,133	50
North Platte Canal and Colonization Co.	14,424	30
Big Horn Basin Development Co.	204,650	50
Plaint Rock Canal	53,162	50
Platte Valley Canal	18,171	30
Rock Creek Irrigation Co.	11,696	45
Sahara Ditch Co.	7,920	50
Sidon Canal and extensions	20,559	30
Tinsleep-Bonanza Canal	16,486	40
Uinta County Irrigation Co.	26,000	35
Wheatland Industrial Co.	33,115	45
Wyoming Land and Irrigation Co.	4,526	50

For comparison with the cost of the foregoing private and Carey Act projects, there is given in the following table a partial list of the projects being built under the terms of the reclamation act showing the total acreages in them and the charges for water rights for completed portions of such projects as far as these have been fixed by public announcement of the Secretary of the Interior. These figures are seen to average a little over $41 per acre.

State.	Project.	Approx. acreage.	Cost per acre. from	to
Arizona-California	Yuma	131,000	$55	$66
Idaho	Minidoka	118,700	22	30
Montana	Sun River	216,346	30	36
Montana-North Dakota	Lower Yellowstone	60,116	45	..
Nebraska	North Platte	129,270	45	55
Nevada	Truckee-Carson	206,000	22	30

[12]Estimated at from $75 to $200 per acre.
[13]Estimated at from $100 to $250 per acre, including land.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

State.	Project.	Approx. acreage.	Cost per acre. from	to
New Mexico	Carlsbad	20,277	$32	$45
Oregon	Umatilla	25,000	60	70
Oregon	Klamath	72,000	30	..
South Dakota	Belle Fourche	100,000	30	35
Washington	Okanogan	9,900	65	..
Washington	Sunnyside	102,824	52	..
Washington	Tieton	34,613	93	..
Wyoming	Shoshone	164,122	45	50

It is interesting to note that the average cost of water from the Government works is about $12 per acre less than from the recent private works of comparable size. The real difference is still greater because of the fact that deferred payments on Government works do not draw interest.

This difference is further accentuated by the greater probability of the water-users under the Government projects receiving an adequate water-supply, as this matter has been given more careful consideration and deficiency guarded against with greater care than in the private investments. In fact, it is known that in a few cases at least there is not water enough for the entire area of land included in these projects. Also, on the Government works, provision in many cases has been made for drainage such as has not been provided by the private works, and the water is, as a rule, brought nearer to the land to be irrigated, still further reducing the cost to the water-user.

Summing up all of these advantages —lower first cost, absence of interest, more dependable water-supply, and more complete works, it would appear to be fair to state that water from the Government projects is obtained at one-half to two-thirds the cost of that from private works here listed, including those built under the terms of the Carey Act.

Geologic Notes on Santa Susanna District

By HENRY R. JOHNSON *

THE recent discovery of an unusually light oil in the Santa Susanna district of eastern Ventura county, California, has aroused considerable speculation as to the conditions under which this oil exists. The occurrence is of considerable technical interest, and the following paragraphs are based upon information furnished by Messrs. Moran and Lewis, whose geologic study in the region preceded the oil discovery.

Attention was first attracted to the region by the realization that several oil-sands and their accompanying strata exposed monoclinally in the foothill region about 2½ miles north of Santa Susanna, dip westward and become involved in a strongly developed asymetric, flat-topped anticline which extends

*Geologist, H. W. Hellman Bdg., Los Angeles, California.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

approximately westward for a considerable distance along the foothills of the north side of the Simi valley. The formations affected by this anticline include certainly the Sespe and Upper Topa-Topa, and possibly the Lower Topa-Topa formations.

The accompanying stereogram (Fig. 1) represents in a generalized way the structural deformation of the oil-bearing series and the manner in which the anticline has been developed on a westward dipping monocline. A discussion of the forces which have produced this condition is not possible in this brief paper; it is sufficient to say that the fold is due to the same general stresses which have resulted in all the east-west structures of this region, notably that along the south side of the Santa Clara river known as the Montebello anticline.

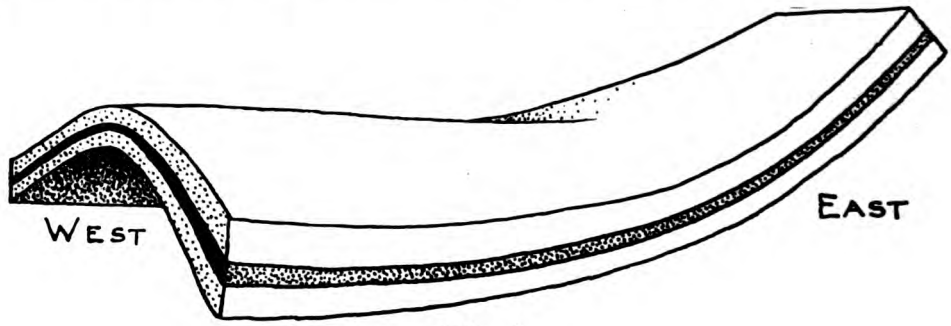


Fig. 1

The Sespe formation consists of a series of alternating sands, clays, and sandy clays which are about equally distributed throughout the whole series, which has a thickness variously estimated at from 3000 to 4500 feet. The sands are massive and light brown in color; they usually contain many beds of conglomerate and locally zones of concretionary nature. The Sespe clays are soft and usually tinted in bands of maroon, red, green, and bluish gray. The sandy clays are usually of a white or bluish tint, and the whole formation is easily eroded into rather sharply defined ridges and gulches. Absolutely no evidence of life during its period of deposition has been found in the Sespe formation.

The Topa-Topa formation underlies the Sespe beds with apparent conformity, but the character of its fossil content indicates an abundance of marine life during much of the period of deposition here.

The following tabulation represents the character and thickness of the various members of the Topa-Topa and Simi region.

	Feet.
Shale and sandy shale	700
Oil zone (oil-sand and interbedded clays)	1000
Clay shale	200
Rusty sand and conglomerate	100
Drab clay shale	2000
Massive sandstone of the Simi hills	?

The fossil evidence in the Topa-Topa formation of the Simi district indicates that the oil series here is the equivalent, in its geologic horizon, of the Eocene oil series of Coalinga. There are two principal oil-sands in the series at Simi, and these are separated from each other by many impregnated sands, from a few inches to 25 ft. in thickness. A third sand from which the prospect-well drilled by the Petrol Company

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

draws its supply lies at or just above the uppermost beds of the Topa-Topa; its total thickness is unknown, but the drill has penetrated it to a depth of about 15 ft., and where tapped at the crest of the anticline the sand lies at a depth beneath the ground surface of about 290 ft. The well is now yielding between 40 and 60 bbl. per day of oil showing a gravity of over 36° Baumé.

Technique.—The oil is now being carefully studied by Dr. Curtiss, of Throop Institute, and preliminary analyses show its unusual character. The following tabulation of results is by Dr. Curtiss.

Cuts.	Vol., %	Average.	Baumé deg.	
I.	10	....20%	73.4	
II.	10		61.3	
III.	6.6		53.5	Gasoline
IV.	4.8	.. 16.6%	50.0	(36%)
V.	5.2	@ 50°	46.2	
VI.	6.0		42.2	
VII.	6.0	....17%	38.8	Kerosene
VIII.	5.0	@ 40°	35.8	(17%)
IX.	4.4	@ 33°	33.0	Distillate (4.4%)
X.	10.0	30% lubri-	31.3	Lubricants
XI.	20.0	cating oils	33.5	(30%)

Another sample tested by Curtiss and Tompkins gives the following results:

Base of oil	asphalt
Paraffin scale	1.15%
Specific gravity (0.8449)	35.7°B.
Flash point (Tagliabue's open tester) below	14°F.
Fire point (Tagliabue's open tester) below	14°F.
Sulphur	0.46%
Sand and water	trace
Calorific value	10,635.5
British thermal units (B.t.u.)	19,144

Ten per cent fractional steam-distillation test, initial distilling point 111° Fahrenheit:

Distilling temp.	At 60°F. Sp. Gr.	°B.
1st 10%, up to 217.4°F.	0.6890	73.2
2nd 10%, 217.4 to 275°F.	0.7372	59.9
3rd 10%, 275 to 311°F.	0.7688	52.1
Steam introduced.		
4th 10%	0.7937	46.4
5th 10%	0.8192	40.9
6th 10%	0.8552	33.7
7th 10%	0.8872	27.8
8th 10%	0.9174	22.6
Residuum or road oil (20%)	0.9830	12.4

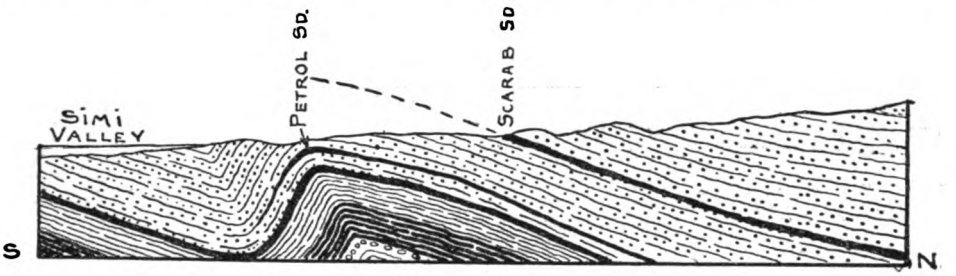


FIG. 2

The above distillation yields commercial products as follows:

	Unrefined products. Per cent.	°B.
Gasoline group	20	66.0
Benzine or naphtha	10	52.1
Kerosene stock	20	43.3
Distillate or neutral cut	10	33.7
Lubricating stock	20	25.4
Residue or road oil	20	12.4
	100	

The striking features of the oil as shown in these analyses are its high gasoline content, the large amount of kerosene, and the unusual viscosity of the lubricant products.

The heavy oil developed in the wells of the Scarab and Union Oil companies, about 2½ miles north of the town of Simi, tap oil-sands which outcrop south of the wells. These sands lie upon the north flank of the Simi anticline, having been eroded countless centuries ago from the region to the south. They have, therefore, absolutely no bearing upon the light oil occurrence in the Santa Susanna district. The above

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

vertical section (Fig. 2) extends from a point about 4½ miles north of Simi southward to a point about a mile east of that town. This section is based upon careful field study and represents the underground conditions with considerable accuracy. The relation between the Scarab sand and that tapped by the Petrol company is well brought out in this drawing.

It has become increasingly apparent that the Ventura county region is attracting renewed interest among oil investors, and, in conclusion, it should be pointed out that the territory is geologically complex and that the haphazard methods of the earlier period of development must be avoided in the future. The present discovery near Santa Susanna has been the logical outcome of several months of painstaking field work, and if future development elsewhere is to be successful, similar methods of study must be applied prior to well location. Only by careful preliminary study may success be attained.

Oil Well Supply Houses Needed in Mexico*

By THOMAS H. BEVAN

A MUCH-FELT need in Tampico is an oil-well supply company, a branch of one or more of the big American firms. At present most of the large supply companies have agents in the field, but these agents can only take orders and wire for the articles needed, causing a delay of several weeks, and heavy loss to the oil companies, which have to close down until the arrival of the necessary articles. The larger companies overcome this trouble by carrying an immense stock in their warehouses, but the smaller ones are not able to go to this expense. All the more important supplies have to be brought from the United States by way of New York or Galveston. There is great competition at the present time in these supplies, and there is no doubt that the company which can supply the article first is the one that will receive the order.

A great expansion of marketing facilities for the oil of the Tampico fields is taking place. Besides the pipe-lines under construction and being planned for the delivery of oil to Tampico, Tuxpam, and Vera Cruz, with one or possibly two lines running to Texas, much attention is being given to providing fleets of oil-carrying vessels [mention of which was made in *Daily Consular and Trade Reports* on February 14, 1912]. Pending the building of these vessels, tank farms are being conconstructed for the storage of the large quantities of oil that cannot be put on the market owing to the impossibility of chartering oil vessels. Even with the somewhat limited storage and marketing facilities, the oil production for this region for the current year has been estimated to be in excess of 20,000,000 bbl. In the first three quarters of this year 4,237,307 bbl., with an invoice value of $2,632,911, was shipped to the United States.

*Vice-Consul, Tampico, State of Tamaulipas.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Engineering Digest

Concrete Pavements*

By CARL M. BOYNTON†

THE principal features of the ideal pavement have been very ably summarized by Linn White, South Park Commissioner of Chicago, as follows: "A pavement should be inexpensive and flexible in cost, simple of construction, without endangering its permanency. It must be dustless, noiseless, resilient, smooth, non-slippery, clean, and of agreeable color to the eye." That concrete pavements practically fulfill all of these requirements has been fully demonstrated wherever they have been intelligently laid.

The two methods of concrete pavement construction which have been used to such an extent throughout the country as to be accepted practically as standards, are single-course and two course work. The relative cost of materials that can be obtained will be the determining factor as to the type of pavement to use. If hard, durable, crushed rock or a clean, hard gravel cannot be obtained at reasonable cost, then one-course work should not be undertaken. Before discussing these types separately there are a few general essentials in the construction of all concrete pavements which should be considered.

The wear to which a concrete pavement is subjected is due to abrasion and impact; therefore, in planning and building a concrete pavement every effort should be directed toward obtaining the highest degree of resistance to such action. It is apparent that to obtain high abrasive resistance in a pavement, an aggregate having high resistance must be used. The same will apply to impact. Therefore, it is essential that concrete for a pavement must be composed of a hard, tough aggregate. But it is just as essential that the concrete itself be uniformly hard and tough, and with the proper materials this can be obtained only by the employment of methods which insure proper proportions—thorough mixing, correct consistence, and uniform distribution and compacting of the concrete over the area being paved. Sand and gravel can be proportioned correctly by wheelbarrows if the wheelbarrows are of the same capacity and each load struck off with a template to insure uniform loading. Thoroughness of the mixing and the use of a definite amount of water for each batch are quite as important as proper proportioning of the aggregate. The concrete should be distributed in a manner which will obtain uniformity throughout. These may be considered excessive precautions, but results indicate the advisability of using precise methods.

A foundation for concrete pavement is essential and should be of such a nature and so prepared that sub-drainage is assured. All soft and spongy material in the sub-base should be removed, and replaced with bank-run gravel, sand, or other material equally as good, and the whole foundation thoroughly compacted with a power roller. A flat sub-base is more easily obtained than one that is crowned, and, on narrow streets up to 20 ft. in width, a better distribution of the concrete results by placing the crown entirely in the pavement proper. A careful checking of the elevations of the foundation is important in order to insure the proper thickness in the finished concrete.

No pavement should be less than 5 in. thick at the outer edge or curb, nor for economical work should it be greater than 8 in. at the crown. In pavements of greater

*Abstract from *Journal* Am. Soc. Eng. Contractors, December 1912.

†Inspecting Engineer, Universal Portland Cement Co., Chicago, Illinois.

Generated on 2024-09-30 00:14 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

width than 20 ft., the desired crown may be obtained by forming both foundation and concrete. An argument often suggested in favor of the crown on the sub-base is that it may more readily drain; but with any kind of foundation material permissible for first-class paving, such a point does not seem well taken, as the water would be cared for amply by sub-base drainage, particularly as but little water will find its way through the concrete into the foundation, but must come through the sub-base material itself up under the pavement.

The one object to be desired in all construction work, and particularly in the use of concrete, is simplicity. The minimum number of operations required to obtain the desired result reduces the probabilities of error and poor workmanship. One-course work, that is, the construction of a pavement where the mixture is similar throughout and the work is done in one continuous operation, is therefore desirable.

The coarse aggregate of one-course work should be well graded gravel or crushed rock, ranging in size from ¼ to 1½ inches in largest dimension. The fine aggregate should be clean coarse sand, well graded from fine to coarse, all of which should pass through a No. 4 sieve, and not over 5% pass through a 100-mesh standard sieve. The cement should be standard portland cement, complying with standard specifications.

The leanest concrete which should ever be used in a one-course pavement is a 1:2:4 mixture. Such proportions will usually give a satisfactory finish and are suitable for streets and roads of moderate traffic. For all other traffic conditions richer mixtures should be used. In some cases concrete composed of 1 part cement, 1½ parts sand, and 3 parts coarse aggregate has been employed with splendid success, and with similar material and under like conditions 1:2:3 mixtures seem to give equally as good results.

As the pavement is dependent for its success upon uniformity, the mixing should be done mechanically in a type of mixer which insures the uniform proportioning of all materials throughout the mass. The concrete should be of a consistence requiring but little tamping to flush the surface with water.

The usual method followed in placing concrete is that of placing the concrete directly on the street from the mixer, and not handling it the second time by wheelbarrows. This is sometimes accomplished by the use of a boom and bucket attached to the mixer, the bucket usually being of the bottom-dump or tilting type, the boom swinging in an arc of 180°. Another method is by the use of a spout or flume from the mouth of the mixer, discharging the concrete directly upon the road, this spout being so attached that it may be swung easily in an arc of 180° and the mix discharged while the spout is in motion. Some types of spouts have broken connections so that after discharging through the extreme sections they may be removed and the concrete placed closer to the mixer. Either method is adapted to economical work.

The thickness of the pavement is a very important question and one which experience alone can answer. Developments to date seem to indicate that at the crown of the road nothing less than 7 in. should be used. In country highways the minimum thickness of the edge should be 6 in., while in some city pavements where the edges are protected by curbs a minimum of 5 in. is allowable.

It is admitted that expansion and contraction must be taken care of in concrete pavements, but the amount of movement which should be provided for and the distances at which joints should be placed, are points not definitely settled. Joints lengthwise through the pavement are objectionable, therefore, in most cases the concrete is placed in a continuous sheet or slab from edge to edge with joints across the pavement, varying from 15 to 30 ft., according to the idea of the engineer writing the specifications. Pavements laid with ⅜ joints every 25 ft. have proved very satisfactory and this arrangement of joints is being accepted as good practice.

Since the edges of the joints are apt to be chipped, it has been found advisable to protect them with plates or angles. Specially prepared plates with anchors sheared and bent back are coming into common use, and, though they add about 5c. per square yard to the cost of the pavement, it is undoubtedly economy to use them. Such plates, 3/16 by 2½ in, are being used in the Wayne county, Michigan, roads and are proving very satisfactory in this work. They are clamped together face to face with a strip of ¼-in. tarred felt between, and are set up and concreted into position. The

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

effective joint, so far as the expansion is concerned, is reduced to whatever the felt can be compressed. In case of street work where curbing is used, longitudinal joints should be provided between the pavement and the curb. These do not require the protection of metal plates; for such longitudinal joints a plastic filler is preferable to a tarred-felt filler. All joints not protected by metal should be rounded to a radius of one-half inch.

It is generally accepted that the best method of finishing a concrete pavement is to wood-float the surface after it is struck off with a template. Sometimes the floated surface is brushed with a stiff fibre broom; but this is not necessary and is not recommended. It is considered advisable to corrugate all grades of 5% or more. At Davenport, Iowa, the corrugations were made with a roller on which the projections were staggered. They were 6 in. long and staggered 4 in. on the roll.

It is impossible to put too much emphasis on the importance of thorough and proper curing of pavements. After the concrete is placed it should be covered with earth, or other absorbent water-retaining materials, which should be kept damp for a period of not less than 5 days, so that the moisture in the concrete, necessary to its proper hardening, will not be lost. The pavement should be protected for at least another period of five days before traffic is allowed upon it.

In some localities, due to available materials, two-course work is better and cheaper than single-course. Such a condition exists where the coarse aggregate is not tough enough to resist traffic, and granite screenings, or a clean sharp sand, can be obtained for the top course. Two-course work requires more careful handling and more experienced labor in its construction than one-course. The difficulty in bonding fresh concrete to partly hardened concrete is well known, and it is this feature that must be watched carefully in two-course work. The bottom course should consist of at least 5½ in. of well-made concrete. The aggregate should conform in general to that described for one-course work, but may consist of material of lower abrasive value. The top course, 1½ inch in thickness, should be composed of a 1:1½ part cement and fine aggregate in which the aggregate is either granite chips graded from fine to ½-in. size, or coarse sand well graded from fine to coarse, the largest particle of which will pass a ½-in. screen.

The main difficulty encountered with two-course work is in placing the wearing course upon the base in such a manner as to ensure a perfect bond. A simple method of ensuring successful work is the use of two mixers —the secondary mixer being used for the top course. In this way the placing of the top is carried along simultaneously with the placing of the base.

The determination of the use of reinforcement in concrete pavement will depend upon the type of foundation and width of pavement. Reinforcement may be used in either single or two-course work and is particularly designed to care for slight settlements of filled-in foundations and to guard against construction cracks developing where the pavement is wide. In any road where a new fill of over 2 ft. is made, and the material used is other than sand or gravel, the pavement should be reinforced no matter what the width of the road. No amount of compacting by roller or puddling can effectively settle such a fill so that no further movement of the foundation is probable after the placing of the pavement.

One condition often arises in towns or cities in the laying of a sewer down the middle or side of a street just prior to placing a pavement. Where such excavation is necessary, and the pavement is laid upon the fresh fill, sufficient reinforcement should be placed near the base of the pavement to give additional strength at such a point. The type of reinforcement which is most economical in price and handling is the wire fabric. The weight of fabric to be used in this reinforcement is still an open question and must be determined to suit each specific case. Light inexpensive reinforcing has been advocated in two-course work; the reinforcement to be placed upon, and pressed into, the still plastic base. Being slightly undulating, it insures that no line of cleavage can possibly develop between the two courses, and in addition it imparts greater strength and security to the pavement. For single-course work the reinforcing is placed about 2 in. from the surface.

An important point in favor of permanent pavement in the country is that the farmer has the road to use in the season when he most needs it. The heavy farm trucking is done in the spring and fall. The concrete

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

pavement is mudless and dustless all the time. It is necessary to adjust the cost per mile to the importance of the road as a thoroughfare, and this can be accomplished by limiting or extending the width of the strip of concrete placed; where on a tributary road it might not be justifiable to place a strip wider than 9 ft., with 3-ft. gravel shoulders; on the main arteries leading into trade centres it would be folly to build less than 14 to 18 ft. of concrete with 3 to 5-ft. gravel shoulders.

The gravel used in the construction of shoulders should be a first-class road gravel containing sufficient clay or earth to cause thorough packing, that it may offer a substantial resistance to traffic. As the gravel shoulders are used only for the purpose of turning out, the wear will not be excessive, and the cost of maintenance will consequently be low. Analysis of cost must include material, mixing and placing, expansion joints, water supply, equipment, and bonds.

An analysis of the material costs of one-course and two-course work will show that the difference is so slight as to be doubtful of estimation. However close an approximation an estimate may be, it cannot be exact, and, therefore, it will readily be seen in the following formulas that the main consideration in choice of type of pavement must necessarily be dependent upon the materials available; and the type chosen will be that to which they are best adapted. This formula is based on Thompson Taylor's table of proportion.

Considering: C = cost of cement per bbl.
G = cost of gravel per cu. yd.
S = cost of sand per cu. yd.

Then, for one-course work of 1:2:3 mix, 7 in. thick, the material cost per square yard of pavement is $0.325C + 0.0975S + 0.146G$; while for two-course work, 7 in. thick, composed of 1:2½:5 base, and a 1:1½ top mortar, the material cost per square yard of pavement is $0.342C + 0.1045S + 0.133G$. These two formulas show the tendency to equalize the cost by small compensating differences in the several quantities and are given here to illustrate this point.

With good equipment and an average gang the actual cost of mixing and placing should not exceed 7c. per square yard for 7 in. of concrete. To this should be added a cost of 3c. per square yard for finishing and labor necessary for handling the forms; making a total for one-course work of 10c. for mixing and placing. As has been stated, there is a slight difference in the cost of placing single and two-course work, with the advantage in favor of the former.

Placing expansion joints is such a simple operation that 1c. per square yard should cover the cost. To this must be added the cost of metal joint and tarred felt delivered on the job, or the cost of filling the joint with a plastic filler.

On city streets the water supply is not a problem; but on country highways, where it is necessary either to haul or to pipe water a considerable distance, it is advisable to make a careful survey of the situation. In estimating the cost of water, the amount required for keeping the pavement damp for a period of 5 days must not be neglected, and as this is an indefinite quantity dependent upon weather conditions, only an approximate cost can be suggested. On the Wayne county, Michigan, work the water for each road is costing $3.50 per day, plus oil and gasoline required in operating the engine and pump; $3.50 is the wage for a man looking after the pumping. Water for the Mukwanago road in Milwaukee costs 1¼c. per cubic yard of pavement. In this case the water is purchased from the city of Milwaukee or its suburbs. In both cases the contractor's and builder's equipment must include the necessary engines, pumps, piping, etc.

The cost of hauling water for use in constructing country highways of concrete is often an item worthy of careful consideration. The method of supplying water by piping is considered by the majority of contractors as most economical. Where water is available under sufficient pressure the pipe-line can be attached directly to the city main, thus eliminating engine and pump, but where water is taken from a well, creek, or river in the vicinity of work, an engine and pump will be required. The cost of gasoline engines varies with rated horsepower from approximately $105 for a 2-hp. engine to $320 for a 9-hp. The cost of pumps would vary according to the capacity pressure required and the conditions under which work would be performed.

On one job in the vicinity of Milwaukee, 7200 linear feet of 2-in. pipe at $6.80 per 100 ft., cost $489.60, and the laying $20 per mile, amounting to $27.20, makes the total cost $516.80, or $0.72 per foot. On the other

Generated on 2024-09-30 00:14 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

job, 11,200 ft. of 2-in. pipe cost $1008 laid, or $0.09 per foot. For supplying water, the city of Milwaukee received $0.005 per cubic yard of concrete mixed, and $0.005 for each square yard of pavement, making a cost of $0.00583 per square yard of finished pavement.

Where the construction is small, the installation of efficient pumping equipment may not be justified, in which case hauling in tank wagons can be resorted to. One team hauling tanks having upward of 350 gal. capacity will supply a mixer of ⅓ cu. yd. with sufficient water for a day's run, provided the haul is 1½ miles or less. On one job of 4800 sq. yd. in Wisconsin, the water cost $75 for the entire work, plus the cost of hauling and pumping, which was $7 per day for 19 days. Another contract was $10 for water and $4 per day for hauling. This work covered 3500 sq. yd., but the haul was short and one team working half a day could keep the mixer supplied.

In discussing the cost of concrete pavements, a few examples of actual construction will help to make clear the division of expense. The first pavement I shall mention was laid recently in a small town in the central part of Illinois, totaling 5000 sq. yd. The total cost of the work was $3,964.02, excluding cost of equipment, which consisted of a ½-yd. Koehring mixer of the latest type and a 4½-hp. gasoline engine, and also excluding the cost of the water for mixing and sprinkling. The pavement was 45 ft. wide and uniformly 6 in. thick. The cost of the work was divided as follows: superintendence, $140; 1457 bbl. of cement, $1545.17; sandstone and gravel, $1284.97; labor, $560.07; lumber and forms, $35; bitumen and creosoted blocks for joints, $48.67; coal and oil for mixer and engine, $30.75; excavation, $307.41. A summation of these figures gives the cost of this road as $4.76 per cu. yd., or $0.79 per square yard.

During the summer, Milwaukee county, Wisconsin, constructed several concrete highways to the south and southwest of Milwaukee. Data on a two day's run from one of these jobs were collected. Twenty-four men and a ⅓-yd. Smith mixer of the dumping type were able to place 94.1 cu. yd. or 470 sq. yd. of 9-ft. road 7 in. thick for a total of $364.41, exclusive of cost of grading and interest and depreciation on equipment. The materials were furnished free to the contractor on the siding nearest the work and hauled to the job at his expense.

In figuring the cost of the road, the cost of materials to the county was included with the cost of mixing and placing carried by the contractor, and are itemized as follows: 111.5 bbl. of cement, $115.96; 93 yd. of bank-run gravel, $94.86; water piped from the city, $19.27; Baker protection plates for expansion joints, $29.07; coal and oil for engine, $4; and labor $101.25; making the cost per cubic yard $3.98 and $0.79½ per square yard.

Another piece of construction work for Milwaukee county was a road 18 ft. wide and 7 in. thick. The work was done by 20 men, using a ½-yd. 'Chain Belt' mixer with chute delivery. The water was piped along the road from the city as in the preceding case, but a 4½-hp. gasoline engine was necessary to force the water up to the head required. The work recorded covered a period of 4 days and cost $1128.46, exclusive of equipment and grading. The cost of piping and water for this and the preceding job was fully accounted for in a former paragraph. The cost of the work was divided as follows: 414 bbl. of cement, $430.92; 92 yd. of sand and 152.3 yd. of gravel, $340.84; water, $60.20; Baker protection plates for expansion joints, $76.50; coal and oil for mixer and engine, $7.50, and labor, $232.50. From these figures we arrive at a cost of $4.70 per cu. yd. and $0.91 per square yard for the pavement.

In southwestern Michigan a short strip 798 ft. long, 9 ft. wide and 7 in. thick, of 1:2:4 concrete, cost $717.83, exclusive of grading, equipment and water. The equipment consisted of a 7-cu. ft. Clover Leaf mixer, necessary wheelbarrows and shovels, and lumber for forms. The gang on this road was much smaller than that of any of the other roads. Two hundred and twenty-five barrels of cement cost $234; 69 yd. of sand cost $37.59; 136.35 yd. of gravel cost $196.34; gasoline and oil for mixer cost $10; Baker plates cost $96; and labor $144, making the cost per cubic yard $4.68 and per square yard $0.91.

In the west central part of Michigan 2586 ft. of concrete 9 ft. 2 in. wide and 0.55 ft. thick were constructed by a township as an experiment. A gang of 12 men using a 7-cu. ft. side-delivery Koehring mixer did the work for a total cost of $3392.62, divided approximately as follows: 746 bbl. of cement,

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

$870; 655.9 yd. of sand and gravel, $553.28; Baker protection plates and filler, $170.12, and labor, $1690.50. These figures give a cost of $7.28 per cubic yard or $1.31 per square yard. Had the cost of grading, excavation, and culverts been added to the above, the cost of pavement would have been increased to $8.73 per cubic yard or $1.46 per square yard.

The last work to which I shall call your attention was constructed in the north central part of Illinois, during October and part of November of this last year. The road is 5500 ft. long, 12 ft. wide, and has a uniform thickness of 6 in. The total cost, not including water, macadam shoulders, and equipment, was $7089.42. The equipment consisted of a ½-yd. Koehring mixer, road grader, plows, scrapers, road roller, and the necessary wheelbarrows and shovels. The materials cost as follows: cement, $2333.65 for 2274 bbl.; 720 yd. of sand, $582.49; 1185 yd. of gravel, $1787.93; operative cost of mixer, $51.99; Baker plates and creosoted wood blocks for expansion joints, $160.03, and labor, $2282.52. The total of these figures determines the cost per cubic yard as $5.80, or $0.96 per square yard. No information was obtained on the cost of water for this work.

The various other expenses, such as depreciation and interest on equipment, are familiar to the contractor, and in making an estimate these will be included with other miscellaneous items such as bonds and profit on the work.

The accompanying table will give a fair idea of the cost of concrete pavement constructed during 1911. It is not our object to cover the cost of excavation, rolling and preparing for the foundation, since such costs apply only to one piece of work or else are of an average character which would have no value for a specific case. By emphasizing the important points necessary in building a concrete pavement and presenting examples of its widespread and satisfactory use, it is hoped that more interest may be aroused in a material which is solving the problem of a low-cost and permanent pavement.

TABLE SHOWING AMOUNT, AVERAGE PRICE AND SOME DETAILS OF CONCRETE PAVEMENTS CONSTRUCTED IN 1911 IN A NUMBER OF CITIES.

	Sq. Yd.	Av. price per sq. yd. including grading	Guarantee Years	Total Thickness of pavement inches	Proportions
Portland, Me.	11,238x	$1.29	. .	6	1:2½:5
Lynn, Mass.	21,402	1.70	5	6	1:2 :4
Trenton, N. J.	2,826	1.44	1	6	1:2½:5
Seymour, Ind.	1,250	.90	3	7	1:6[2]
Edwardsville, Ill.	8,950	1.40	½	7[2]	1:3 :5
Alpena, Mich.	13,000	1.30	.	8	1:6
Escanaba, Mich.	12,000	.87	0	6½	. . .
Fond du Lac, Wis.	11,043x	1.25	5	6½	1:2½:5
Sheboygan, Wis.	19,860x	1.28	0	8½[5]	. .
Bemidji, Minn.	19,826	.90*	2	5	1:3½
Burlington, Iowa	4,489	1.34	5	6½	1:2 :5
Cedar Rapids, Iowa	2,178	1.16*	. . .	7[8]	1:3 :5
Davenport, Iowa	13,208	1.23*	2	7[8]	1:3 :5
Fort Dodge, Iowa	7,900	1.60	5	7[7]	1:3 :5
Marshalltown, Iowa	14,000	1.18	0	7	1:3 :5
Mason City, Iowa	42,000	1.30	5	7[8]	1:2 :5
Sioux City, Iowa	100,000	1.20	.	5	1:3 :4½
Kansas City, Mo.	81,000	1.05	5	6	1:2½:4½
Grand Island, Neb.	3,754	1.30	. . . .	. . . .	. . . . .
Omaha, Neb	4,485	. . . .	. . . .	. . . .	. .
South Omaha, Neb.	13,200	1.30	5	6[10]	1:2½:5
Kansas City, Kan.	. . . .	1.09	5	6	. .
Ottawa, Kans.	996	1.03*	2	6	1:2 :3
Wichita, Kans.	2,137	1.00*	2	6	1:2 :4
Billings, Mont.	2,000	2.25	2	7½[11]	1:6
Boise, Idaho	23,166	1.12*	. . .	6	1:3 :5[12]
Grand Junction, Col.	18,000	2.20	. . .	7[13]	1:3 :6
Vancouver, Wash.	15,220	1.15*	. . . .	5	. .
Portland, Ore.	31,417	. . . .	. . . .	. . . .	. . .
Salem, Ore.	85,266	1.30*	0	6	1:2 :4

*Does not include grading. x Reinforced.
[1] 1:6 mix., 1:2 surface. [2] 5 in. base, 1:3:5 mix.; 2 in. top of 1 cement, 1 small gravel, 1 sand. [3] 4 in. base, 2 in. wearing surface. [4] 5 in. base 1:2½:5; 1½ in. top, 1 cement, 1 sand, 1 gravel. [5] 6½ in. at gutter, 8½ in. at center. [6] 5 in. 1:3:5 mix., 2 in. top 1:2. [7] 5 in. base, 1:3:5 mix., 2 in. top 1:1. [8] 5 in. base 1:2:5, 2 in. top 1:2. [9] 1½ in. 2:3 grout; 5½ in. 1:7 mix. [10] 6 in. sand 5 in. [11] Laid in 6 in. gravel base, pavement, 6 in. 1:6 gravel base and 1½ in. 1:2 mortar top. [12] Also 1:3:7. [13] 5 in. base, 2 in. top. [14] 5 in. of 1:3:5 and 1½ in. of 1:2.

Modern Street Railway Track Construction*

By C. B. VORCE

As an expenditure of many thousands of dollars is involved, a very careful study should be made before a type of permanent track construction is adopted. In many cases, failure has occurred by reason of a lack of study of the character of the foundations, and a type not at all suitable to existing conditions has been chosen simply because other railroads have used that type successfully.

I have had very poor results with the girder type of construction. This type was the standard when I became connected with the British Columbia Electric Railway Co., Ltd., of Vancouver, but, on account of poor foundations, the girders had broken badly.

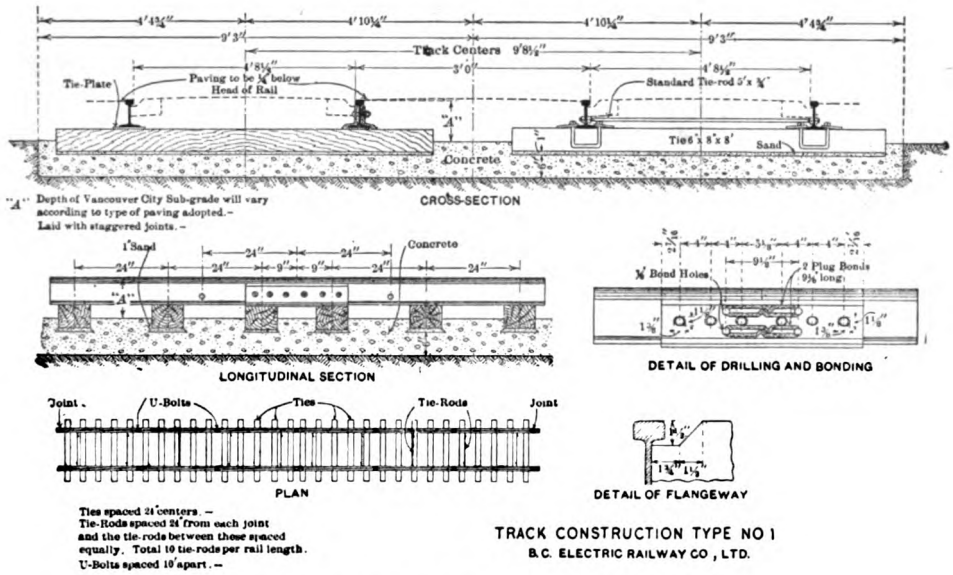
*Abstract from *Proc.* Am. Soc. Civil Engineers, February 1913.

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

with most disastrous results to both pavement and track. After a careful study, I recommended, and the management adopted, the type of construction shown in Fig. 1. Since that time about 15 miles of double track of this type has been laid, and as yet no signs of failure can be seen.

It is my opinion that it is possible to build too rigid a track, which increases both car and track maintenance. The concrete between the ties and under the rail will shrink, allowing the rail to move slightly. I am in favor of wooden ties, spaced 2 ft. from centre that the joints are only about 6% of the total track length, it is readily seen to be good business to make the joints as nearly perfect as possible.

Although the company has bought the best paving bricks obtainable on the Pacific coast, the results with them in forming a flangeway on the running side of the rail have been very poor, as the bricks break off at the nose very quickly; for this reason the company has been forced to adopt granite flangeway blocks, although the cost is at least 50% greater.



BRITISH COLUMBIA RAILWAY TRACK CONSTRUCTION.

to centre, surfaced on about 1 in. of sand, which acts as a cushion. This type has given excellent satisfaction in Vancouver, and is not as noisy and rigid as the steel tie construction.

As to the life of the wooden ties: On special work in Vancouver, ties which have been embedded in concrete for 14 years have been taken up and found to be perfectly sound.

Grinding the rail ends so that each shall be in the same horizontal plane is a matter of vital importance. The rail ends vary, and, no matter how slight this variation may be, unless they are ground to the same height, pounding at the joints will occur, cupping will commence, and the track will fail at the joints while the remainder is in perfect condition. When it is remembered

As many of the streets in Vancouver are paved with wood blocks, which are narrower than the granite flangeway blocks, no bond is possible, and a straight joint parallel to the rail results. With the girder construction, it is almost impossible to keep these flangeway blocks in place, due to the moving of the rail on account of broken girders. Since the adoption of the slab type of construction, which gives a solid foundation, there has been very little trouble.

During the coming season I propose to lay a concrete monolith, 8 in. wide, parallel to the running side of the rail, in which the flangeway is formed. As this will be laid at the same time as the pavement foundations and form a part of it, it is hoped that this will overcome the difficulty of loose flangeway blocks, and reduce the mainten-

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ance and upkeep charges accordingly.

In selecting a type of permanent track construction in Vancouver, one must remember that the conditions are not the same as in older established cities where macadamized streets have been in existence for years and a good foundation is available. Owing to the poor foundation, the streets were first planked and then macadamized, the macadam seldom being renewed before laying the permanent pavement on a concrete base. For this reason the foundation is very poor, and the problem has been the selection of a type of construction to meet the existing conditions.

On paved streets, the company always lays a double track, and, as the city pays for all paving for the entire width between the curbs, including foundation, the railway company's liability covers only whatever construction it decides to put in below. Before I took charge of this work, although under the franchise the company could do its own portion of the work, it had been the practice to let it to the paving contractor. Such poor results were obtained that a construction department was organized and equipped, and, with few exceptions, the company now does all its own work. At my suggestion, in order to facilitate the work, the company entered into an arrangement with the city to do all the work in the track allowance, about 18½ ft. wide, the city paying for its share at the same rate as was paid to the contractor for the remainder of the street. This enabled the railway company to do its portion of the work first, the contractor following and bringing his work to the grade established by the rails. This plan has given most satisfactory results.

The work is carried on in the following manner: A temporary track is laid, outside of the track allowance, to take care of the traffic during construction, thus enabling the company to build both tracks at once. When the traffic is turned over to the temporary tracks, the old track is torn up and the ties and rails are piled on the side of the street, ready to be picked up by the work train, grading is then started, and the cut is taken out to rough grade; forms are then set by the company's engineer to the proper grade for the top of the slab, and a small gang of fine graders follows up the rough graders; in the meantime the gravel for the slab is delivered along the side of the excavation. As soon as a block has been rough-graded, work on the concrete slab is commenced, the material being shoveled directly into the hopper, on which a line has been drawn to insure the right proportions. The aggregate is then run through the mixer and delivered into a bucket which travels along a 30-ft. boom cable swinging through 180°. This method reduces the number of men around the mixer to the minimum, which is an important item, as common labor is paid 37½c. per hour. All the company's mixers are of this type, and can mix about 80 cu. yd. per 10 hours, or about 250 lin. ft. of completed slab 18½ ft. wide and 6 in. deep. The rails are distributed by an electric derrick car and the ties by the company's motor car. As soon as the slab has set for 24 hours, ties are distributed, T-rails (70-lb., 264, Lorain section, or 87-lb., 399, Lorain section) are laid, and the track is surfaced to grade with sand. The standard plan calls for 1 in. of sand under the tie, but, owing to irregularities in the concrete, the thickness varies from ¾ to 1¼ in. After the track has been surfaced, the sand is scraped out from between the ties, the flat wheels on the mixer are replaced by flanged wheels, so that the mixer can be run on the track, and the final concrete course is laid.

It will be seen that the four operations, grading, laying the slab, laying the track, and putting in the final concrete course, are all carried on at the same time, resulting not only in speed but in economy.

Each section of track laid represents a new problem, and from time to time I have had to design special machinery in order to do the work quickly and economically. On Granville street, the principal business street, though the paving was in good condition, about one-half mile of track was in such bad repair that it had to be renewed. The Board of Public Works allowed the company to abandon traffic on this street on condition that it would be restored in 22 days. As this period included 10 days for the last concrete laid to set, it meant that all work, except paving, had to be completed in 12 days. In order to be sure of carrying out the work on time, a progress chart, Fig. 2, was prepared, and was followed so closely that the work was finished 1 hour ahead of time.

The street was paved with wood blocks laid on a 6-in. concrete base, and each rail of the double track was carried on a concrete girder, 24 in. wide and 15 in. deep. The reconstruction of the track called for the re-

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

moval and replacing of the following quantities: 5100 sq. yd. of wood block paving; 10,200 ft. of rail; 1800 cu. yd., or 5100 sq. yd., of concrete; 600 cu. yd. of earth; the laying of 2400 cu. yd. of concrete; ½ mile of double track; 850 sq. yd. of concrete flangeway blocks; and 4250 sq. yd. of wood block paving. The quantity of concrete to be removed was so great, and the time allowed so short, that some mechanical means for breaking it up had to be devised, as the schedule called for the removal of about 32 sq. yd. per hour. The dipper arm was taken off the electrically-driven shovel owned by the company, and pile-driver leads, 20 ft. long, were hung from the end of the boom, being held in place by two braces running back to the main frame of the shovel. A 2600-lb. hammer was specially cast, having a wedge-shaped cutting edge, about 8 in. deep, running parallel to the track. The cutting edge was placed in this way in order that it would not injure the remaining concrete in the street. This scheme worked excellently, and no trouble whatever was found in breaking up the concrete and adhering to the schedule. The concrete breaker, which would swing through 360°, was placed on one track, and on the other track was placed the derrick car, having a 60-ft. boom which would also swing through 360°, and could move itself along the track. The larger pieces of concrete were picked up by the derrick and loaded on flat cars placed behind the concrete breaker, and the smaller material and earth were loaded in skips and then into wagons standing alongside the excavation. As soon as the concrete was broken for a rail length, the concrete mixer and derrick car were backed up on the old track and the operation was repeated. Work was carried on in two 10-hour shifts, and the cost was as follows: Taking up wood blocks, 8.9c. per sq. yd.; tearing up old track, 11c. per ft. of single track; breaking up concrete, 40c. per sq. yd.; excavating, loading, and dumping, 82½c. per cu. yd.; removing material by teams and work-train, 65c. per cu. yd. These figures may seem high, but when one remembers the rate paid for common labor, and that teams are paid $8 per shift of 10 hours during the day and $9.50 per shift for night work, I do not think that the cost was excessive.

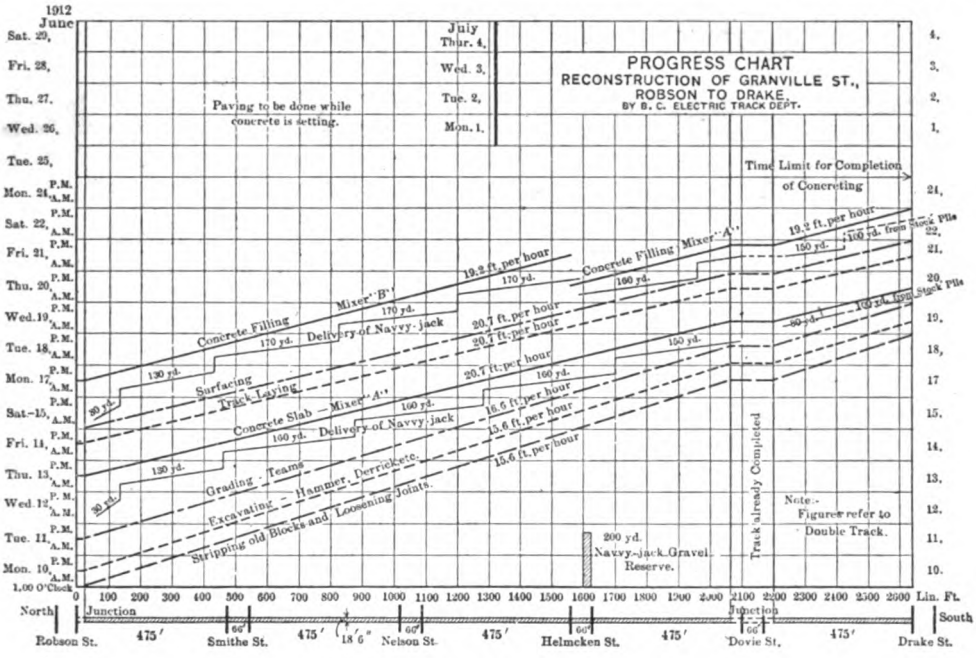


FIG. 2. TRACK CONSTRUCTION PROGRESS CHART.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Concrete and Reinforced Concrete

Special committees were appointed in 1903 and 1904 by the American Society of Civil Engineers, American Society for Testing Materials, American Railway and Maintenance of Way Association, and the Association of American Portland Cement Manufacturers for the purpose of investigating current practice and providing definite information concerning the properties of concrete and reinforced concrete, and to recommend necessary factors and formulas required in the design of structures in which these materials are used. A progress report of the work done by the committee has been published in the Proceedings of the American Society of Civil Engineers for February 1913, from which the following has been abstracted.—EDITOR.

1. Standard Cement Specifications*

GENERAL OBSERVATIONS

1.—These remarks have been prepared with a view to pointing out the pertinent features of the various requirements and the and the precautions to be observed in the interpretation of the results of the tests.

2.—The committee would suggest that the acceptance or rejection under these specifications be based on tests made by an experienced person having the proper means for making the tests.

SPECIFIC GRAVITY

3.—Specific gravity is useful in detecting adulteration. The results of tests of specific gravity are not necessarily conclusive as an indication of the quality of a cement, but when in combination with the results of other tests may afford valuable indications.

FINENESS

4.—The sieves should be kept thoroughly dry.

TIME OF SETTING

5.—Great care should be exercised to maintain the test pieces under as uniform conditions as possible. A sudden change or wide range of temperature in the room in which the tests are made, a very dry or humid atmosphere, and other irregularities, vitally affect the rate of setting.

CONSTANCY OF VOLUME

6. The tests for constancy of volume are divided into two classes, the first normal, the second accelerated. The latter should be regarded as a precautionary test only, and not infallible. So many conditions enter into the making and interpreting of it that it should be used with extreme care.

7. In making the pats, the greatest care should be exercised to avoid initial strains due to molding or too rapid drying-out during the first 24 hours. The pats should be preserved under the most uniform conditions possible, and rapid changes of temperature should be avoided.

8. The failure to meet the requirements of the accelerated tests need not be sufficient cause for rejection. The cement, however, may be held for 28 days, and a re-test made at the end of that period, using a new sample. Failure to meet the requirements at this time should be considered sufficient cause for rejection, although in the present state of our knowledge it cannot be said that such failure necessarily indicates unsoundness, nor can the cement be considered entirely satisfactory simply because it passes the tests.

GENERAL CONDITIONS

1. All cement shall be inspected.

2. Cement may be inspected either at the place of manufacture or on the work.

3. In order to allow ample time for inspecting and testing, the cement should be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

4. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

5. Every facility shall be provided by the contractor, and a period of at least 12 days allowed for the inspection and necessary tests.

6. Cement shall be delivered in suitable packages, with the brand and name of manufacturer plainly marked thereon.

7. A bag of cement shall contain 94 lb. of cement net. Each barrel of portland cement shall contain 4 bags, and each barrel of natural cement shall contain 3 bags of the above net weight.

*Adopted August 16, 1909, by the American Society for Testing Materials.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

8. Cement failing to meet the 7-day requirements may be held awaiting the results of the 28-day tests before rejection.

9. All tests shall be made in accordance with the methods proposed by the Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society on January 7, 1912, with all subsequent amendments thereto.

10. The acceptance or rejection shall be based on the following requirements:

NATURAL CEMENT

11. *Definition.*—This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

FINENESS

12. It shall leave by weight a residue of not more than 10% on the No. 100, and 30% on the No. 200 sieve.

TIME OF SETTING

13. It shall not develop initial set in less than 10 min., and shall not develop hard set in less than 30 min., or more than 3 hours.

TENSILE STRENGTH

14. The minimum requirements for tensile strength for briquettes 1 sq. in. in cross-section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Neat Cement Age.	Strength, pounds.
24 hours in moist air	75
7 days (1 day in moist air, 6 days in water)	150
28 days (1 day in moist air, 27 days in water)	250
One Part Cement, Three Parts Standard Ottawa Sand	
7 days (1 day in moist air, 6 days in water)	50
28 days (1 day in moist air, 27 days in water)	125

CONSTANCY OF VOLUME

15. Pats of neat cement about 3 in. diameter, ½ in. thick at the centre, tapering to a thin edge, shall be kept in moist air for a period of 24 hours.

(*a*) A pat is then kept in air at normal temperature.

(*b*) Another is kept in water maintained as near 70°F. as practicable.

16. These pats are observed at intervals for at least 28 days, and, to pass the tests satisfactorily, should remain firm and hard and show no signs of distortion, checking, cracking, or disintegrating.

PORTLAND CEMENT

17. *Definition.*—This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3% has been made subsequent to calcination.

SPECIFIC GRAVITY

18. The specific gravity of cement shall be not less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made on a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

FINENESS

19. It shall leave by weight a residue of not more than 8% on the No. 100, and not more than 25% on the No. 200 sieve.

TIME OF SETTING

20. It shall not develop initial set in less than 30 min.; and must develop hard set in not less than 1 hour, nor more than 10 hours.

TENSILE STRENGTH

21. The minimum requirements for tensile strength for briquettes 1 sq. in. in cross-section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Neat Cement Age.	Strength, pounds.
24 hours in moist air	175
7 days (1 day in moist air, 6 days in water)	500
28 days (1 day in moist air, 27 days in water)	600
One Part Cement, Three Parts Standard Ottawa Sand	
7 days (1 day in moist air, 6 days in water)	200
28 days (1 day in moist air, 27 days in water)	275

CONSTANCY OF VOLUME

22. Pats of neat cement about 3 in. diameter, ½ in. thick at the centre, and tapering to a thin edge, shall be kept in moist air for a period of 24 hours.

(*a*) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

(*b*) Another pat is kept in water maintained as near 70°F. as practicable, and observed at intervals for at least 28 days.

(*c*) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for 5 hours.

23. These pats, to pass the requirements satisfactorily, shall remain firm and hard, and show no signs of distortion, checking, cracking, or disintegrating.

SULPHURIC ACID AND MAGNESIA

24. The cement shall not contain more than 1.75% of anhydrous sulphuric acid (SO_3), nor more than 4% of magnesia (MgO).

(*b*) *Metal Reinforcement**

6.—Steel shall be made by the open-hearth process. Re-rolled material will not be accepted.

7.—Plates and shapes used for reinforcement shall be of structural steel only. Bars and wire may be of structural steel or high-carbon steel.

8.—The chemical and physical properties shall conform to the following limits:

11.—Chemical determinations of the percentages of carbon, phosphorus, sulphur, and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for, in which case an excess of 25% above the required limits will be allowed.

12.—*Plates, Shapes, and Bars.*—Specimens for tensile and bending tests for plates and shapes shall be made by cutting, from the finished product, coupons which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾ in. with enlarged ends.

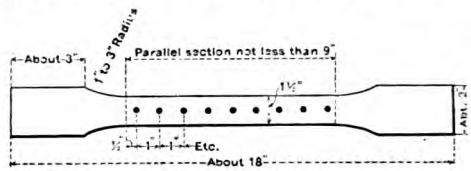


FIG. 1. STANDARD TEST PIECE

Elements considered.	Structural steel.	High-carbon steel.
Phosphorus, maximum { Basic	0.04 per cent.	0.04 per cent.
Phosphorus, maximum { Acid	0.06 " "	0.06 " "
Sulphur, maximum	0.05 " "	0.05 " "
Ultimate tensile strength.	Desired.	Desired.
Pounds, per square inch	60,000.	88,000
Elong. min. percentage in 8 in., Fig. 1	1,500,000*	1,000,000
	Ult. tensile strength.	Ult. tensile strength.
Character of fracture	Silky	Silky or finely granular.
Cold bends without fracture	180° flat†	180° $d = 4t$‡

*See Paragraph 15. †See Paragraphs 16 and 17. ‡"$d = 4t$" signifies "around a pin having a diameter four times the thickness of the specimen."

9.—The yield point for bars and wire, as indicated by the drop of the beam, shall not be less than 60% of the ultimate tensile strength.

10.—If the ultimate strength varies more than 4000 lb. for structural steel or 6000 lb. for high-carbon steel, a retest shall be made on the same gauge, which to be acceptable, shall be within 5000 lb. for structural steel, or 8000 lb. for high-carbon steel, of the desired ultimate.

13.—Bars shall be tested in their finished form.

14.—At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing ⅜ in. and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

15.—For material less than 5/16 in. and more than ¾ in. in thickness the following modifications will be allowed in the require-

*Adopted March 16, 1910, by the American Railway Engineering Association.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ments for elongation:

(*a*) For each 1/16 in. thickness below 5/16 in., a deduction of 2½ will be allowed from the specified percentage.

(*b*) For each ⅛ in. thickness above ¾ in., a deduction of 1 will be allowed from the specified percentage.

16.—Bending tests may be made by pressure or by blows. Shapes and bars less than 1 in. thick shall bend as called for in paragraph 8.

17.—Test specimens 1 in. thick and greater shall bend cold 180° around a pin, the diameter of which, for structural steel, is twice the thickness of the specimen, and for high-carbon steel, is 6 times the thickness of the specimen, without fracture on the outside of the bend.

18.—Finished material shall be free from injurious seams, flaws, cracks, defective edges, or other defects, and have a smooth, uniform, and workmanlike finish.

19.—Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled on it, except that bar steel and other small parts may be bundled, with the above marks on an attached metal tag.

20.—Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks, or other imperfections, or is found to have injurious defects, will be rejected, and shall be replaced by the manufacturer at his own cost.

21.—All reinforcing steel shall be free from excessive rust, loose scale, or other coatings of any character which would reduce or destroy the bond.

2.—Suggested Formulas for Reinforced Concrete Construction.

These formulas are based on the assumtions and principles given in the chapter on sign.

(*a*) *Standard Notation.*

1.—*Rectangular Beams.*

The following notation is recommended.

f_s = tensile unit stress in steel.
f_c = compressive unit stress in concrete.
E_s = modulus of elasticity of steel.
E_c = modulus of elasticity of concrete.
$n = \frac{E_s}{E_c}$
M = moment of resistance, or bending moment in general.
A = steel area.
b = breadth of beam.
d = depth of beam to centre of steel.
k = ratio of depth of neutral axis to effective depth d.
z = depth of resultant compression below top.
j = ratio of lever arm of resisting couple to depth d.
$jd = d - z$ = arm of resisting couple.
p = steel ratio (not percentage).

2.—*T-Beams.*

b = width of flange.
b' = width of stem.
t = thickness of flange.

3.—*Beams Reinforced for Compression.*

A' = area of compressive steel.
p' = steel ratio for compressive steel.
f_s' = compressive unit stress in steel.
C = total compressive stress in concrete.
C' = total compressive stress in steel.
d' = depth to centre of compressive steel.
z = depth to resultant of C and C'.

4.—*Shear and Bond.*

V = total shear.
v = shearing unit stress.
u = bond stress per unit area of bar.
o = circumference of perimeter of bar.
Σ_o = sum of the perimeters of all bars.

5.—*Columns.*

A = total net area.
A_s = area of longitudinal steel.
A_c = area of concrete.
P = total safe load.

(*b*) *Formulas.*

1.—*Rectangular Beams.*

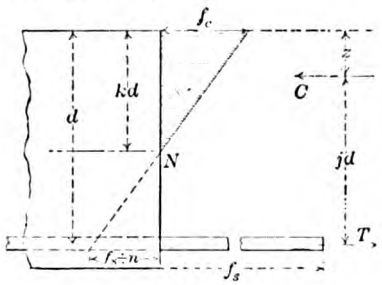


FIG. 2.

Position of neutral axis,

$$k = \sqrt{2pn + (pn)^2} - pn \qquad (1)$$

Arm of resisting couple,

$$j = 1 - \frac{1}{3}k \qquad (2)$$

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

(For $f_s = 15{,}000$ to 16,000, and $f_c = 600$ to 650, k may be taken at $\frac{3}{8}$)

Fiber stresses,

$$f_s = \frac{M}{Ajd} = \frac{M}{pjbd^2} \quad (3)$$

$$f_c = \frac{2M}{jkbd^2} = \frac{2pf_s}{k} \quad (4)$$

Steel ratio, for balanced reinforcement,

$$p = \frac{1}{2} \frac{1}{\frac{f_s}{f_c}\left(\frac{f_s}{nf_c} + 1\right)} \quad (5)$$

2.—*T-Beams.*

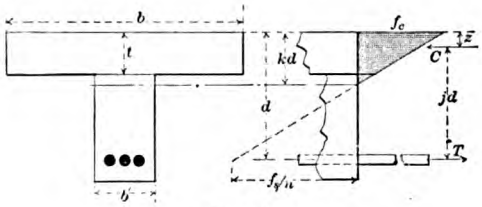


FIG. 3.

Case I. When the neutral axis lies in the flange.

Use the formulas for rectangular beams.

Case II. When the neutral axis lies in the stem.

The following formulas neglect the compression in the stem:

Position of neutral axis.

$$kd = \frac{2ndA + bt^2}{2nA + 2bt} \quad (6)$$

Position of resulting compression,

$$z = \frac{3kd - 2t}{2kd - t} \frac{t}{3} \quad (7)$$

Arm of resisting couple,

$$jd = d - z \quad (8)$$

Fiber stresses,

$$f_s = \frac{M}{Ajd} \quad (9)$$

$$f_c = \frac{Mkd}{bt\left(kd - \frac{1}{2}t\right)jd} = \frac{f_s}{n}\frac{k}{1-k} \quad (10)$$

(For approximate results the formulas for rectangular beams may be used.)

The following formulas take into account the compression in the stem; they are recommended where the flange is small compared with the stem:

Position of neutral axis,

$$kd = \sqrt{\frac{2ndA + (b-b')t^2}{b'} + \left(\frac{nA + (b-b')t}{b'}\right)^2} - \frac{nA + (b-b')t}{b'} \quad (11)$$

Position of resultant compression,

$$z = \frac{\left(kdt^2 - \frac{2}{3}t^3\right)b + \left[(kd-t)^2\left(t + \frac{1}{3}(kd-t)\right)\right]b'}{t(2kd-t)b + (kd-t)^2 b'} \quad (12)$$

Arm of resisting couple,

$$jd = d - z \quad (13)$$

Fiber stresses,

$$f_s = \frac{M}{Ajd} \quad (14)$$

$$f_c = \frac{2Mkd}{[(2kd-t)bt + (kd-t)^2 b']jd} \quad (15)$$

3.—*Beams Reinforced for Compression.*

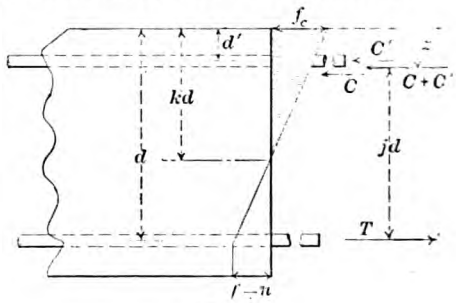


FIG. 4.

Position of neutral axis,

$$k = \sqrt{2n\left(p + p'\frac{d'}{d}\right) + n^2(p+p')^2} - n(p+p') \quad (16)$$

Position of resultant compression,

$$z = \frac{\frac{1}{3}k^3 d + 2p'nd'\left(k - \frac{d'}{d}\right)}{k^2 + 2p'n\left(k - \frac{d'}{d}\right)} \quad (17)$$

Arm of resisting couple,

$$jd = d - z \quad (18)$$

Fiber stresses,

$$f_c = \frac{6M}{bd^2\left[3k - k^2 + \frac{6p'n}{k}\left(k - \frac{d'}{d}\right)\left(1 - \frac{d'}{d}\right)\right]} \quad (19)$$

$$f_s = \frac{M}{pjbd^2} = nf_c\frac{1-k}{k} \quad (20)$$

$$f_s' = nf_c\frac{k - \frac{d'}{d}}{k} \quad (21)$$

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

4.—*Shear, Bond, and Web Reinforcement.*

In the following formulas, Σ_0 refers only to the bars constituting the tension reinforcement at the section in question, and jd is the lever arm of the resisting couple at the section.

For rectangular beams,

$$v = \frac{V}{bjd} \qquad (22)$$

$$u = \frac{V}{jd\ \Sigma_0} \qquad (23)$$

(For approximate results, j may be taken at $\frac{7}{8}$)

The stresses in web reinforcement may be estimated by the following formulas:

Vertical web reinforcement,

$$P = \frac{Vs}{jd} \qquad (24)$$

Web reinforcement inclined at 45° (not bent-up bars),

$$P = 0.7\,\frac{Vs}{jd} \qquad (25)$$

in which P = stress in single reinforcing member, V = amount of total shear assumed as carried by the reinforcement, and s = horizontal spacing of the reinforcing members.

The same formulas apply to beams reinforced for compression as regards shear and bond stress for tensile steel.

For T-beams,

$$v = \frac{V}{b'\,jd} \qquad (26)$$

$$u = \frac{V}{jd\ \Sigma_0} \qquad (27)$$

(For approximate results, j may be taken at $\frac{7}{8}$.)

5.—*Columns.*

Total safe load,

$$P = f_c\,(A_c + nA_s) = f_c\,A\,(1 + (n-1)\,p) \qquad (28)$$

Unit stresses,

$$f_c = \frac{P}{A\,(1 + (n-1)\,p)} \qquad (29)$$

$$f_s = n\,f_c \qquad (30)$$

Generator and Prime Mover Capacities*

By DAVID B. RUSHMORE and ERIC A. LOF

THE chief distinctive characteristic of electrical apparatus is that its capacity is limited by thermal considerations. Electrical generators are of necessity driven by prime movers, and the combination must be treated as a single unit when considering the questions of ratings and capacities. Such prime movers as steam-engines, steam turbines, gas-engines, and water-wheels have various limitations regarding their output which must be considered in connection with that of the electric generators they are driving. The proper adjustment of ratings for generators and prime movers with these different limitations as determined by the conditions of service, is the object of this paper. In direct-current generators the limitation imposed by commutation has almost entirely been removed by the use of interpoles. With alternators as now constructed, the limitation of output due to regulation of the machine is but seldom found; therefore, the question of heating may be regarded as the important factor for consideration. Under certain conditions of violently fluctuating loads or intermittent service, the questions of commutation and regulation may, however, become of considerable importance.

The capacity of an alternator is limited not only by the actual energy load which the machine is carrying, but also by the power-factor of such load. The additional heating at low power-factors and constant power is due to the wattless component of the armature current and also to the addi-

*Abstract from *Proc.* Am. Inst. E. E., March 1913.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

decreases with an increase in gate opening. The margin between the point of maximum efficiency and of maximum capacity depends upon the specific speed of the runner, and is smaller the higher the specific speed. This is illustrated in Fig. 5, which shows that as the specific speed is increased, the point at which maximum efficiency occurs approaches nearer to the power delivered at full gate opening. The specific speed may thus be increased to such an extent that the points of maximum efficiency and maximum output coincide. With low heads and high specific speeds, it is therefore desirable to operate wheels near their point of maximum output, and to obtain the best results the generator should be designed giving consideration to this point.

Referring again to the curves in Fig. 5, it will be noted that the full-load capacity occurs at about 6% above normal or rated full load in all three cases. This is in accordance with the general practice, the margin being allowed for governing. It is also noted that for curves *B* and *C* the efficiency is falling off very rapidly at 6% overload, and that should the gate be opened still further, the output would decrease instead of increase. If with low specific speed wheels, as represented by curve *A*, the gates were still further opened, the power would continue to increase to some extent.

The point of maximum efficiency for wheels represented by curve *A* occurs at about 90% of normal full load, in the case of *B* at 93.5%, while in the case of *C* the maximum efficiency occurs just at the point of normal or rated full load. Thus, as stated before, the power at which the maximum efficiency occurs approaches nearer to full load as the specific speed increases.

With high-head wheels, as represented by curve *A*, the efficiency remains high over a large range in power, while for low-head wheels, curve *C*, the efficiency falls off rapidly as the power is reduced below the normal full load. For this reason it is desirable to run low-head wheels under practically full-load conditions. With high-head wheels this is not so important, as the efficiency is still high at partial loads. With wheels as represented by curve *C*, it is also necessary to allow some margin above the normal full load for governing, as it is desirable to operate the turbine at its point of maximum efficiency. With high-head wheels, curve *A*, such a margin need not be allowed.

The curves plotted in Fig. 5 represent operating conditions under constant head. This, however, is not always realized, especially in low-head plants where floods and dry seasons sometimes cause quite a variation in the head, and this has, as previously mentioned, quite a bearing on the selection of the water-wheel, and should therefore be given careful consideration.

If the speed of the unit could be allowed to vary at all times as the square root of the ratio of the heads, the shape of the performance curve for any head other than normal would be the same as that secured at normal head, but the output would vary as the 3/2 power of the ratio of the heads. In the case of wheels driving alternating-current generators, a speed variation is not permissible, and the speed must be kept constant irrespective of any variation in head which may occur.

In Fig. 6 is plotted a set of curves illustrating the effect of a varying head. A 10,000-hp. turbine is assumed to operate normally under a 32-ft. (9.75 m.) head, the speed to be constant for a range of heads from 26 to 38 ft. (7.92 to 11.6 m.). As the head goes up to 38 ft. (11.6 m.) the shape of the curve approaches more closely curve *B* in Fig. 5, while when the head falls to 26 ft. (7.92 m.), the speed being constant, it approaches more closely to curve *C*. In other words, when operating under a 38-ft. (11.6-m.) head, the speed is lower than the best speed for the runner under that head, while when operating under the 26-ft. (7.92-m.) head, the speed of the wheel is higher than the best speed. Under 38-ft. (11.6-m.) head, the point of maximum efficiency is, furthermore, considerably below the normal full load at that head, while under 26-ft. (7.92 m.) head the power at which maximum efficiency occurs is the actual full load, illustrating the points discussed above in reference to the relation of the power at which maximum efficiency occurs and the normal full-load power for various specific speeds.

Let us assume that a selection of a wheel is to be made for an installation, and that performance curves are desired, showing the expected efficiency for various loads and speeds. Curves *A*, *B*, and *C* in Fig. 5 may each represent a possible curve, dependent upon the revolutions selected for the turbine in question, the revolutions being directly proportional to the specific speeds,

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

a question of desirable overload capacity which limits the rating of the turbine.

In the water-wheel unit, the efficiency usually falls off rapidly above and below the maximum point, so that the rating of the

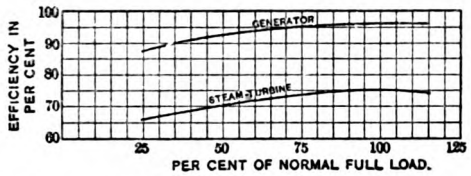


FIG. 4. PERFORMANCE CURVES OF 5000-KV. TURBO GENERATOR SET.

generator should correspond to the point of maximum efficiency of the water-wheel. Steam-engines and steam turbines are designed to operate with certain variations both in pressure of the steam and conditions of vacuum. Gas-engines must accommodate themselves to variation in the quality of the gas. With the water-wheels, however, the large majority of installations are subject to a change in head which varies over a wide percentage. In many of the low-head installations the back water may bring about a change in head which is beyond the capacity of one wheel to accommodate, and in some plants additional wheels must be mounted on the same shaft and cut into service at times of low head. One instance of this kind is the plant of the Chattanooga & Tennessee River Power Co. where the head may vary from 20 to 42 ft. (6.1 to 12.8 m.). In most of the large developments this change in head is the limiting feature in the design of the water-wheel as related to the generator capacity, for in all electrical work it is necessary that the speed of the generator be kept constant.

Water-wheel runners of different designs are compared on the basis of their specific speeds. The specific speed of a water-wheel is the number of revolutions per minute at the point of maximum efficiency that a similar wheel will give when it delivers one horse-power under one meter-head. By comparison of the specific speeds, we can judge of the characteristics of water-wheel runners without respect to their actual speed, power, or head. A high specific speed means a high actual speed, and a low specific speed means a low actual speed in revolutions per minute. For this reason water-wheels with low specific speeds are generally used with high heads in order to make the speed of the generator within the range of good electrical design.

Water-wheels with high specific speeds have very deep runner vanes, and these are liable to erosion under high heads; also, the efficiency curves of high specific speed runners are more pointed than with the low specific speed type, and this allows a narrower margin for operation under the best conditions. This is clearly shown in curves in Fig. 5.

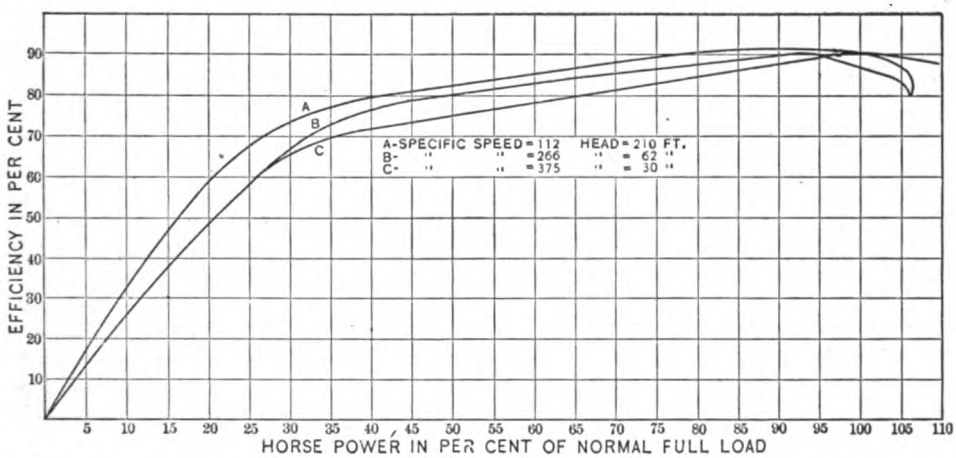


FIG. 5—PERFORMANCE CURVES OF SEVERAL TURBINES FOR VARIOUS HEADS AND SPECIFIC SPEEDS AS SHOWN

The maximum full-load capacity of a turbine is that point beyond which the output

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

decreases with an increase in gate opening. The margin between the point of maximum efficiency and of maximum capacity depends upon the specific speed of the runner, and is smaller the higher the specific speed. This is illustrated in Fig. 5, which shows that as the specific speed is increased, the point at which maximum efficiency occurs approaches nearer to the power delivered at full gate opening. The specific speed may thus be increased to such an extent that the points of maximum efficiency and maximum output coincide. With low heads and high specific speeds, it is therefore desirable to operate wheels near their point of maximum output, and to obtain the best results the generator should be designed giving consideration to this point.

Referring again to the curves in Fig. 5, it will be noted that the full-load capacity occurs at about 6% above normal or rated full load in all three cases. This is in accordance with the general practice, the margin being allowed for governing. It is also noted that for curves *B* and *C* the efficiency is falling off very rapidly at 6% overload, and that should the gate be opened still further, the output would decrease instead of increase. If with low specific speed wheels, as represented by curve *A*, the gates were still further opened, the power would continue to increase to some extent.

The point of maximum efficiency for wheels represented by curve *A* occurs at about 90% of normal full load, in the case of *B* at 93.5%, while in the case of *C* the maximum efficiency occurs just at the point of normal or rated full load. Thus, as stated before, the power at which the maximum efficiency occurs approaches nearer to full load as the specific speed increases.

With high-head wheels, as represented by curve *A*, the efficiency remains high over a large range in power, while for low-head wheels, curve *C*, the efficiency falls off rapidly as the power is reduced below the normal full load. For this reason it is desirable to run low-head wheels under practically full-load conditions. With high-head wheels this is not so important, as the efficiency is still high at partial loads. With wheels as represented by curve *C*, it is also necessary to allow some margin above the normal full load for governing, as it is desirable to operate the turbine at its point of maximum efficiency. With high-head wheels, curve *A*, such a margin need not be allowed.

The curves plotted in Fig. 5 represent operating conditions under constant head. This, however, is not always realized, especially in low-head plants where floods and dry seasons sometimes cause quite a variation in the head, and this has, as previously mentioned, quite a bearing on the selection of the water-wheel, and should therefore be given careful consideration.

If the speed of the unit could be allowed to vary at all times as the square root of the ratio of the heads, the shape of the performance curve for any head other than normal would be the same as that secured at normal head, but the output would vary as the 3/2 power of the ratio of the heads. In the case of wheels driving alternating-current generators, a speed variation is not permissible, and the speed must be kept constant irrespective of any variation in head which may occur.

In Fig. 6 is plotted a set of curves illustrating the effect of a varying head. A 10,000-hp. turbine is assumed to operate normally under a 32-ft. (9.75 m.) head, the speed to be constant for a range of heads from 26 to 38 ft. (7.92 to 11.6 m.). As the head goes up to 38 ft. (11.6 m.) the shape of the curve approaches more closely curve *B* in Fig. 5, while when the head falls to 26 ft. (7.92 m.), the speed being constant, it approaches more closely to curve *C*. In other words, when operating under a 38-ft. (11.6-m.) head, the speed is lower than the best speed for the runner under that head, while when operating under the 26-ft. (7.92-m.) head, the speed of the wheel is higher than the best speed. Under 38-ft. (11.6-m.) head, the point of maximum efficiency is, furthermore, considerably below the normal full load at that head, while under 26-ft. (7.92 m.) head the power at which maximum efficiency occurs is the actual full load, illustrating the points discussed above in reference to the relation of the power at which maximum efficiency occurs and the normal full-load power for various specific speeds.

Let us assume that a selection of a wheel is to be made for an installation, and that performance curves are desired, showing the expected efficiency for various loads and speeds. Curves *A*, *B*, and *C* in Fig. 5 may each represent a possible curve, dependent upon the revolutions selected for the turbine in question, the revolutions being directly proportional to the specific speeds,

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

and they will illustrate the manner in which the efficiencies at partial gate openings will fall off in any one case, depending upon the actual revolutions per minute selected for the design of the wheel. They will also give an idea as to the margin between the normal full load and the power at which the point of maximum efficiency will occur. In the selection of a speed for any installation, therefore, aside from the cost of the generators, the question of the wheel efficiencies at partial gate openings has a considerable bearing. Where a unit is likely to operate under a very wide range in power it would be advisable to select a wheel represented by curve *A*, giving a high efficiency for a considerable range in power.

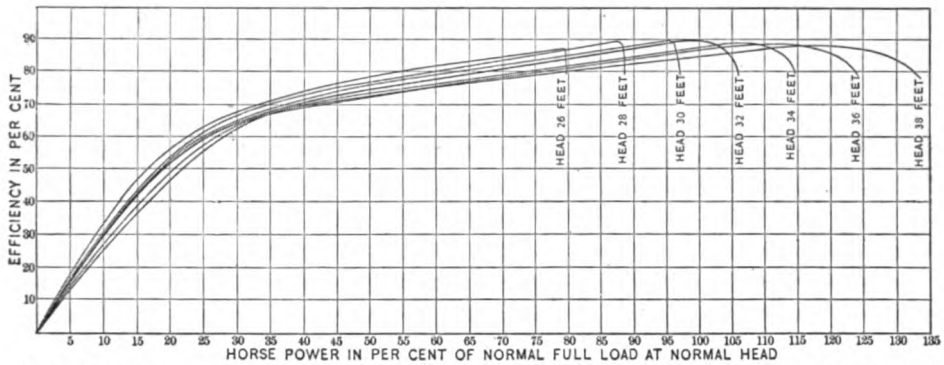

EFFICIENCY IN PER CENT
HEAD 26 FEET
HEAD 28 FEET
HEAD 30 FEET
HEAD 32 FEET
HEAD 34 FEET
HEAD 36 FEET
HEAD 38 FEET
HORSE POWER IN PER CENT OF NORMAL FULL LOAD AT NORMAL HEAD

FIG. 6—10,000 H.P. TURBINE-CURVES SHOWING EFFICIENCY AND POWER FOR CONSTANT SPEED AND A NORMAL HEAD OF 32 FT. FOR VARIOUS HEADS AS SHOWN

All power systems have a more or less varying load, and this has an important bearing on the selection of the proper generating equipment and on the economy of the plant. The load will vary considerably, not only during the 24 hours of the day, but also for different periods during the year. The load curve also differs materially for different kinds of load, such as for central stations, industrial establishments, street railways, etc.; a typical load-curve of a central station is represented in Fig. 7.

The size and capacity of the units in a hydro-electric station is determined, in many cases, quite largely by the hydraulic conditions. In operating, the number should, wherever possible, never be less than four, unless the station forms a part of a larger system. It is better to operate machines as near full load as possible, and to start new units instead of utilizing overload capacities. Where sudden overloads of considerable magnitude come on the system for very short periods, it is, of course, necessary to have a wheel capacity sufficient to care for them.

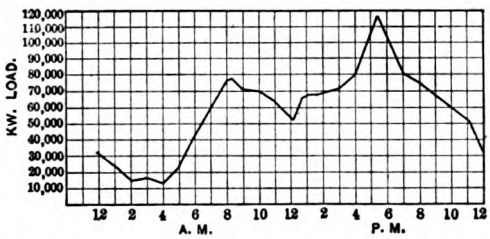


FIG. 7. TYPICAL LOAD CURVE OF LARGE CENTRAL STATION—DECEMBER LOAD.

The foregoing discussion indicates that water-wheel characteristics will vary with different installations. For the sake of standardization it is desirable to give the generators a maximum rating at a certain temperature. The proper relation of the capacities of generator and water-wheel should be considered for each installation.

Generated on 2024-09-30 00:15 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Columbia River Power Project*

By L. F. HARZA and V. H. REINEKING

THE proposed power-site is on the Columbia river about 90 miles east of the city of Portland, and 187 miles above the mouth of the river. The Columbia river is now navigable with ease for deep-draft ocean vessels to the mouth of the Willamette river, 98 miles above the mouth, and for the remaining 89 miles, is navigable at all except extreme high-water stages, for vessels of 8-ft. draft, the power-site being at the present head of navigation.

The proposed point of diversion is on the Washington side of the river, at the head of what is known as Five Mile rapids, and about 5 miles east of the city of The Dalles, Oregon. The river at this point suddenly contracts from a width at low water of about 1600 ft. to a width of about 200 ft., and remains nearly this narrow throughout the length of Five Mile rapids, or to Big Eddy, about 1½ miles below.

The proposed location of the power-house is at the 'Big Eddy,' the project therefore requiring a canal about 8500 ft. in length, from the point of diversion to power-house site.

The Columbia river is one of the largest streams in the United States. Above the power-site under consideration, it drains an area of approximately 250,000 square miles, much of which is mountainous. Many of its tributaries are fed by melting snows and glaciers in the high altitudes, to which fact is to be attributed its most prominent characteristics of flow, namely: the regularity of the occurrence of its annual flood in June when the rainfall on its drainage area is very small, and its general steadiness of flow, free from the sudden and unexpected floods and droughts so common to Middle West streams at almost any season of the year.

The natural fall at extreme low water is about 12 ft., from which it increases to about 35 ft. at 500,000 sec. ft., decreasing again to about 32 ft. in maximum flood.

The development of the project requires a canal in solid rock about 1½ miles long, the side wall of which, adjacent to the river channel, would need to be built to the same maximum head water elevation, or about to elevation 150, regardless of the head utilized. To maintain a constant operating head the canal would need to be made very deep in order to be below the low head-water elevation at times of minimum flow. The cost of machinery per unit capacity would be nearly identical, as the total installation would be governed by the minimum head, which would be nearly the same in either case. Since the power of the stream is proportional to the product of discharge by head, it is best to utilize a greater head under low-water conditions, and thus obtain a greater amount of power, allowing the additional discharge at higher river stages to compensate for the reduced head by the installation of additional machinery.

The tail-water elevation is beyond our control. The head-water elevation is limited by the grade of two transcontinental railways, one on each bank of the river. The O.-W. R. & N. railroad, built before the 1894 flood, suffered from overflow at that time for a considerable distance, and should this flood again recur, it would again be damaged. It is evidently impossible, therefore, to assume a minimum head at time of extreme flood in excess of the present natural head at that time, 32 ft., as otherwise the railroad would be damanged by the power plant through a considerable distance.

The extreme maximum flood has occurred but one day in 32 years, a flood of 1,300,000 sec. ft. having maintained in 1894 for a period sufficient to average about 0.2 of a day per year for the past 32 years; 1,200,000 sec. ft. for about 0.44 of one day and 1,000,000 sec. ft. for about 1.8 days per year. If the history of all steam and hydro-electric stations were known, and if such history extended over a period of 32 years, it is probable that very few, if any, could be found which had not, due to some cause, been out of service at least once during the 32 years, and for a period as great as would have been caused by the 1894 flood.

Under these conditions the net operating head which could be utilized at the proposed power station after deducting for the loss or

*Abstract from Bulletin No. 3, Report of John H. Lewis, State Engineer of Oregon.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

fall in the water surface of the canal, would be about 42 feet.

With this assumed minimum head the maximum practical range of satisfactory operation would limit the maximum head to about 85 ft. with the turbines adjusted to operate at best efficiency at about 60 ft. head. The minimum tail-water elevation at ordinary river stages (not extreme minimum) is about elevation 50, which with 85 ft. head, and by allowing for a drop in the water surface of the canal, would require a head-water elevation of about 137 ft. under low-water operating conditions.

In summarizing the head conditions it may be said that the plan recommended would permit operation of the plant at maximum possible low-water capacity consistent for the good of the machinery, with its ability to operate satisfactorily under a head of 42 ft.; this head being the maximum that can be maintained without damage to valuable property, during such maximum flood, the probability of the recurrence of which is sufficiently great to warrant provision for the maintenance of full power at such times; with the possibility of operation at part capacity up to nearly the extreme floods which are known to have occurred.

The power of the stream based upon the assumption of 50,000 sec. ft. minimum flow, and 73 ft. maximum simultaneous operating head, would be about 330,000 hp. delivered to the generators. This is based upon 80% turbine efficiency, which is the best that could be depended upon under these conditions where the turbine is operating at a head considerably above that for which its speed is best fitted. The power which could be delivered to the switchboard after allowing for generator losses would be approximately 300,000 horse-power.

Due to the immense size of this proposed power plant, the machinery to be installed would, in order to reduce the total number of generating units to a reasonable figure, need to be greater in size than any units yet constructed. As a tentative basis upon which to estimate the cost of the proposed installation, it would seem best to adopt a unit consisting of a generator of 20,000 kw. normal rating, driven by a turbine of 32,000 hp. capacity at 70 ft. head. Eleven of these units would be required to deliver 300,000 hp. at 70 ft. head and, with the overload capacity of the turbines in service, at 42 ft. head, 20 such units would be required. These turbines would be essentially a duplicate in size of the ones at present being installed in the plant of the Mississippi River Power Co., at Keokuk, Iowa, which, however, are to operate at a head of only 32 ft. and are of the largest size which can be transported by rail.

The estimate of cost will be made sufficiently large to cover the cost of 21 units (one reserve unit), each of 20,000 kw. capacity, of the high-speed type used at Keokuk, or of the cost of 30 units of proportionately smaller size and of lower speed type. There will also be included the cost of the necessary governors and exciting machinery.

It is recommended that the electrical equipment consist of 21 (twenty for service and one spare unit), three-phase, 11,000-volt, 60-cycle generators, rated at 20,000-kw. normal capacity, 70% power factor or whatever power factor may seem probable at time of purchase. The required excitation would be about 1% of the generator rating or about 4000 kw. This could be provided by direct-connected exciters (200 kw. per unit), by hydraulically driven exciters exclusively, or by their combination with motor generator sets. The estimate will cover either scheme.

The plan adopted for purposes of estimate embraces a dam at the head of Five Mile rapids, a canal about 8500 ft. long on the Washington side, and a power-house at Big Eddy.

Our plan contemplates the construction of a diversion channel large enough to accommodate the entire flood flow of the river, for permanent as well as for construction purposes, a rock-fill dam, to be built well above the maximum flood level. This diversion channel would first be completed and provided with a removable type of dam.

The bottom of the diversion channel would be above the ordinary river stage and the work therefore prosecuted in the dry unless for the annual flood. This removable dam is not only made necessary as a closing feature, but also for the regulation of the river after completion. With the completion of the diversion channel and removable dam, but a small rise would divert the low-water flow through this channel. By using only very large rocks taken from the excavation, and having them stored nearby for use, one low-water working season should be sufficient time in which to build a rock fill dam to a sufficient height to divert

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

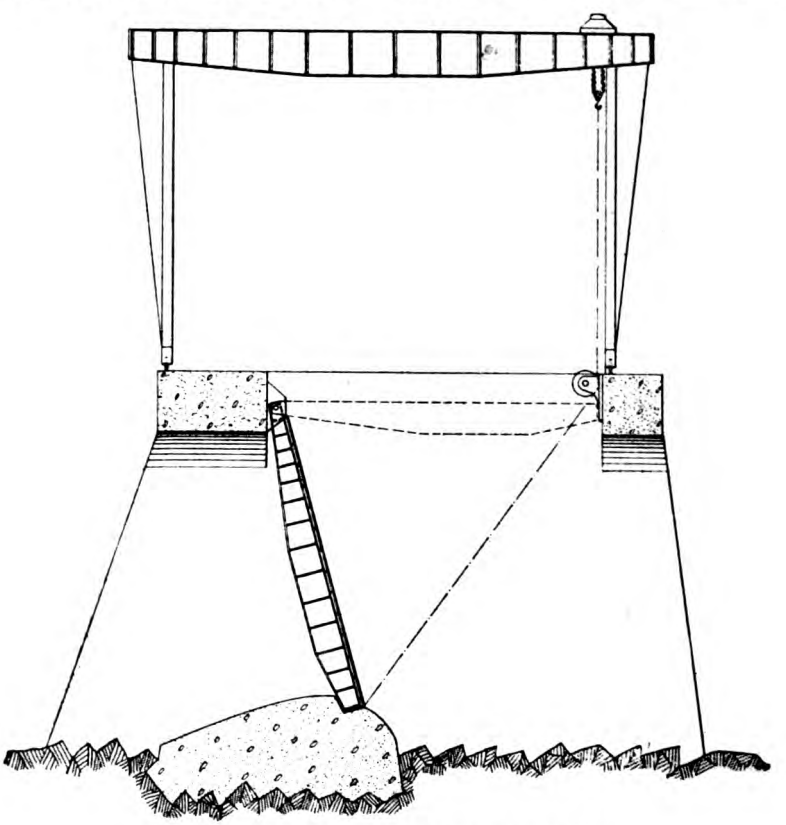
the succeeding floods through the channel and prevent overtopping of the rock fill.

During high water the head would be nearly balanced on both sides, and by eliminating overflow, the dam would be fully as safe as at low water, even though not completed to its final cross section.

Should the weight of the rocks be insufficient to hold them in place before the fill is brought above the water surface, they could temporarily be anchored until the fill should have diverted the water, after which the need of anchorage would cease. An immense structural steel and chain skeleton which would obstruct the water but little and yet retain the rock, might be sunk in the channel; or the upstream toe of the dam could be built in the comparatively quiet water above the neck, and rocks could be at first placed in pairs chained together, one in this quiet water and one in the gorge below. The dam would later be filled in between, making all material useful. This feature is believed to be possible of accomplishment, by one of these or other available methods.

The type of removable dam best suited to the conditions is probably a modification of the Camere type at first built in 1876-80, in the Port Villez dam and similar to those now being built for the emergency dams on the Panama canal, at Gatun, Pedro Miguel, and Miraflores, except for the substitution of a permanent bridge instead of the draw span as at Panama.

The illustration shows a general cross-section of the proposed dam. The dam would consist of large concrete piers, spaced about 100 ft. centre to centre with concrete sills arched if necessary, and at the top heavily reinforced concrete beams or horizontal steel girders enclosed in concrete, between the piers. Wicket girders of ordinary plate girder type, arranged in pairs would be hinged by pins to the horizontal beam between piers and rest in an inclined position on the concrete sill. These wicket girders would support the steel gates or wickets, which would travel upon rollers. By means of cables running from the lower end of the girders to the hoisting machinery,



TENTATIVE CROSS-SECTION OF REMOVABLE DAM.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

each pair of girders is made to revolve on its hinges, the upstream end of the girders being raised up or let down as desired. After the wicket girders are lowered in place, the gates are allowed to roll down on the girders until they reach their proper position. The same machinery could be used for raising the gates as for raising and lowering the girders. The machinery would consist of large gantry cranes traveling along the entire length of the dam.

On account of the great depth of water in Big Eddy, the power-house has been located back from the water's edge. This necessitates a large amount of extra rock excavation, but by leaving a temporary wall of rock between the power-house and the river, a cofferdam would be eliminated and excellent foundations assured.

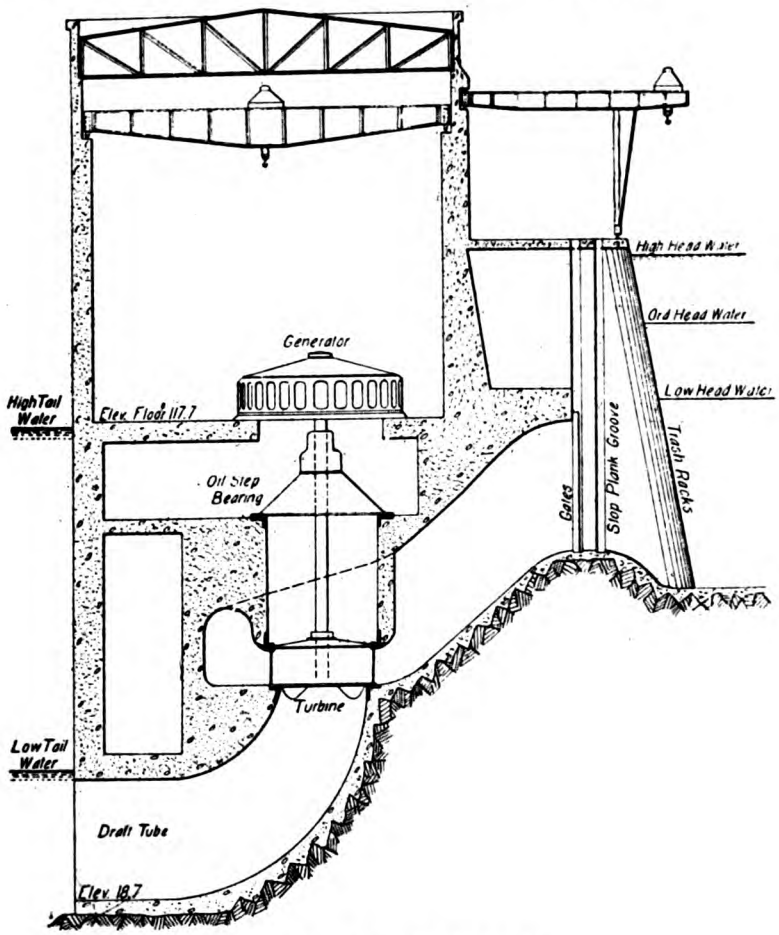
The illustration shows cross-section of the power-house, upon which estimates of cost have been based, and which involves no extraordinary features except size. Generating units are assumed to be spaced 50 ft. on centres, requiring a total length to include also exciting units of about 1200 feet.

Our estimates of quantities are based upon a detailed topographical map of the site and upon tentative drawings of the power-house, dam, etc.

The prices on hydraulic, electric, and other equipment, are based upon tentative prices for this work secured from several companies engaged in the manufacture of the various items. We believe a sufficient amount has been added to these prices to allow for any probable advance in the price of labor and materials.

The following unit prices have been used in preparing the estimate of cost:

Rock excavation, per cu. yd.	$1.00
Concrete, per cu. yd.	7.00
Rock fill, per cu. yd.	0.80
Structural steel, per lb.	0.04½



CROSS-SECTION OF POWER-HOUSE.

Generated on 2024-09-30 00:16 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The total cost of the proposed development is estimated as follows. No transformers or high tension equipment are included:

Dam	$ 5,733,000
Canal and fishway	2,800,000
Power-house	3,703,000
Machinery	6,700,000
Changes in railroads	200,000
General contingent fund	1,000,000
	$20,136,000
Engineering, legal, and preliminary expenses, 6%	1,260,000
	$21,396,000
Interest during construction, two years at 4%	1,680,000
Total development cost	$23,076,000

On a basis of 300,000 continuous electrical horse-power, this cost of development is $77 per horse-power.

In estimating the annual cost of power, we have assumed a 50-year life for the canal, dam, and concrete structures, including the building; and a 15-year life for machinery, trash racks, wicket gates, girders, cranes, and all other steel works. We have added a depreciation fund in the form of a 3% sinking fund, sufficient to replace each part of the plant at the end of its assumed life.

The rate of interest on capital cost has been based upon the issuance of state bonds, according to instructions. Costs of operation and repairs are based upon known figures for several smaller sized stations, with due consideration for difference in size. Upon this basis the total annual cost of power at the low tension busbars of the generating station is estimated as follows:

Interest at 4%	$ 920,000
Depreciation on machinery and structural steel work	419,000
Depreciation on all other items	104,000
Operating expenses, including administration	125,000
Maintenance and repairs	500,000
Total	$2,068,000

On a basis of 300,000 continuous electrical horse-power, this annual cost of producing power is $6.89 per horse-power.

We estimate that extra 10,000 kw. units for operation under flood head for supplying surplus summer power for irrigation and other purposes, would cost about $450,000 per 10,000 kw. unit, including building, foundations, and electrical equipment, or about $35 per horse-power, which is much less than the cost of the initial installation ($77).

The above estimated cost of $6.89 per horse-power is based upon power at generated voltage (11,000 volts), at the station busbars, and also based upon an immediate sale of the entire base load of 300,000 electrical horse-power.

This demand could hardly be realized under the most favorable conditions even for a much smaller block of power, and if not, then such accumulated interest and other annual charges as could not be met from the current income would add a 'going value,' upon which returns should be expected, to the initial capital investment previously estimated. In addition there should be a margin for safety, although this margin should be as small as practicable if the use of power is to be encouraged.

Most consumers who might be interested in this power would probably reside in the immediate vicinity and use the power at generated voltage. Transmission to distant markets would be largely, at least, contingent upon, and subsequent to, the securing of distant contracts, and transmission charges would not therefore be of the same speculative nature as the initial generation expenses.

We have therefore thought best to assume a base price at generated voltage, including therein all margin to cover the contingencies and profit above discussed, and to add to this price the actual estimated charges against transmission and transformation. For this purpose a base price of $9 per horse-power per year would seem to allow a fair margin and yet encourage the use of the power. This figure will be assumed in determining the cost of delivering power at Umatilla, Portland, Salem, and Eugene.

The costs are very largely dependent upon the relative situation of the points of delivery and the amount of power required. Certain elements of the cost of transmission lines, such as right-of-way, steel towers, insulators, and construction expense, vary but little with the amount of power to be transmitted. Also certain annual charges, both fixed charges and maintenance, are nearly independent of the amount of power.

If two points of delivery are so situated

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

that they can be served by short branches from one trunk line, they can be served much more cheaply per horse-power than if separate lines to each point were required.

Transmission lines are assumed to be first-class steel-tower construction on private right-of-way, duplicate 110,000-volt 3-phase lines, and one ground wire, suspension-type insulators, and the following sizes of copper. The assumed sizes of wire are sufficient to allow of a considerable increase in power consumption:

	B&S Gauge.
The Dalles to Umatilla	No. 0000
The Dalles to Portland	No. 0000
Portland to Salem	No. 2
Salem to Eugene	No. 4

The assumed amounts of power and estimated annual cost of same, delivered and stepped down ready for distribution, are as follows:

	Kw.	Hp.	Per hp.
Umatilla	30,000	40,000	13.71
Portland	20,000	27,000	14.40
Salem	5,000	6,700	18.33
Eugene	5,000	6,700	25.10

The annual cost thus estimated, for Eugene at least, is undoubtedly greater than the cost for which power could be delivered to that point from nearby developments. If, however, more power were to be used at that point, and if neighboring cities were also to take power from the same line, the annual charge per delivered horse-power could be very greatly reduced.

The following estimates of the cost of delivering power in Ontario were made by the Ontario Hydro-Electric Power Commission, and are interesting as representing conditions nearly similar to yours. The Commission buys power at Niagara Falls from the Ontario Power Co. at the following prices:

"$9.40 for power at 12,000 volts until 25,000 hp. or more is taken, then $9 for all. $10.40 for power at 60,000 volts until 25,000 hp. or more is taken, then $10 for all. If power taken at higher voltage, price to be fixed by arbitration."

Name of town.	Miles from Niagara Falls	Quantity of power applied for in hp.	Est. maximum cost of power
Toronto	78	10,000	$18.10
Hamilton	36	1,500	17.50
London	95	5,000	23.50
Brantford	65	1,500	21.50
Guelph	75	2,500	24.00
Stratford	112	1,500	24.50
St. Thomas	109	1,500	26.50
Woodstock	69	1,200	23.00
Berlin	95	1,000	24.00
Galt	93	1,200	22.00
Hespeler	84	400	26.00
St. Mary's	119	500	29.50
Preston	88	600	23.50
Waterloo	97	685	24.50

The following table shows the estimate of the Ontario Hydro-Electric Power Commission for the cost of distribution from municipal sub-stations to an individual consumer. The conditions are not exactly comparable with those obtaining here, but the table is interesting as an approximate estimate:

COST OF HORSE-POWER PER ANNUM FOR THE DELIVERY OF VARIOUS AMOUNTS OF POWER

Miles from sub-station.	50 hp.	75 hp.	100 hp.	150 hp.	200 hp.	250 hp.	300 hp.	
2	$ 5.58	$ 4.20	$ 3.53	$ 2.92	$ 2.74	$ 2.60	$ 2.51	
3	6.89	5.20	4.41	3.60	3.25	3.10	3.03	
4	7.92	6.18	5.20	4.27	3.93	3.72	3.86	2200 volts
5	8.87	7.18	5.98	4.96	4.55	4.32	4.17	
6	10 20	8.24	6.77	5.38	5.13	4.60	4.43	
8	14.10	10.14	8.40	6.97	6.24	5.79	5.58	11,000 volts
10	16.12	12.13	9.54	8.31	7.68	6.96	6.17	
12	18.76	14.03	11.12	10.12	8.42	7.96	7.22	16,500 volts
15	22.74	17.08	13.48	10.89	9.35	8.84	8.32	

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Company Reports

The Pacific Water Co., through its chief engineer, George H. Wilhelm, has submitted a report of its real estate holdings to the Oakland City Council, as follows:

Division January 1, 1913.	
Central reservoir site	$ 125,250
Linda Vista reservoir	6,500
East Oakland pipe yards	18,000
Broadway reservoir	6,475
Highland park reservoir	12,600
East Oakland pumping plant	1,625
Machine-shop	37,500
Office building and equipment	82,500
24th Avenue pumping station	6,000
Dimond pump plant (no figures given)	.....
Alvarado wells and pumping plant	95,330
San Leandro lake and watershed grant land	1,846,350
San Leandro lake and watershed patented land	1,282,714
Total	$3,520,844

Real estate not actually in use, but covered by trustees' mortgage:

Myrtle-street pumping plant	$ 2,250
Oakland-avenue pumping plant	1,760
Orange-street reservoir	6,000
Pleasanton property	24,719
Laundry farm reservoir site	11,220
Other Oakland lots	2,200
Total	$48,149

Capacity of reservoirs, Oakland division:

Total in gallons	5,677,790,000

Total draft on sources, 1912:

San Leandro lake, gallons	1,764,896,500
Alvarado wells, gallons	2,783,979,092
San Pablo creek, gallons	25,538,000
Total gallons	4,574,413,592

The San Francisco, Napa & Calistoga Railway Co. has reported earnings for the years ended February 29, 1912, and February 28, 1913, as follows:

	1913.	1912.
Gross earnings	$206,724	$183,618
Operating expenses	116,039	103,310
Net earnings	90,685	80,308

Net earnings were two and a half times interest of $36,000 on the $600,000 6% first-mortgage bonds. There still remained a surplus of $54,685, applicable to interest of $30,500 on the $610,000 5% debentures. The net surplus of $24,185 is equal to 1.2% on the $2,000,000 common stock outstanding.

Great Western Power Co. has reported for the year 1912 as follows:

Income account.	
Operating revenues	$2,409,600.95
Operating expenses—	
Generating	365,739.76
Current purchased	115,469.03
Transmitting	100,183.50
Division operating	189,470.60
Steam service operating	21,643.02
General office expense	236,244.64
Taxes	84,027.33
Rent of leased plant	238,000.00
	$1,350,777.88
Net operating revenue	$1,058,823.07
Non-operating revenue—	
Rents	$ 238,649.00
Interest	22,106.61
	$1,319,578.71
Funded debt interest	856,778.77
Other interest	7,223.97
	$ 864,002.74
Net income	$ 455,575.97

The Pacific Light & Power Corporation has reported for the year ended December 31, 1912, as follows:

	1912.	1911.
Gross earnings	$2,446,578	$2,255,277
Expenses and taxes	1,446,683	1,228,699
Net earnings	999,895	1,026,576
Other income	100,313	39,398
Total income	1,100,208	1,065,976
Bond and other int.	481,072	471,342
Balance	619,136	594,634

The result of operations for the month of January 1913 as compared with January 1912:

	1913.	1912.
Gross earnings	$229,777	$197,508
Expenses and taxes	128,450	111,686
Net earnings	101,327	85,822
Other income	10,227	2,201
Total income	111,554	88,023
Bond and other interest	41,542	43,846
Surplus	70,012	44,177

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Engineering Bonds

THE California Telephone & Light Co., operating a telephone and electric lighting and power-distribution system in Sonoma, Lake, Mendocino, and Napa counties, has filed with the Railroad Commission an application for permission to purchase the electric light and power distribution system of the Cloverdale Light & Power Co., operating in Cloverdale and vicinity. The application also includes a request for authority to put a first mortgage on the maximum amount of $5,000,000 on the property of the California Telephone & Light Co., and asks permission to immediately issue and sell $350,000 par value at 6% bonds to be secured by this mortgage. The earnings of the combined properties during the year 1912 were as follows: Gross, $90,485.82; expenses, $50,275.14; profit, $40,210.68; interest, $10,917.50; balance, $29,293.18. It is stated that the company in its telephone department has 1419 subscribers who are served through property comprising 464 miles of telephone pole line with 1763 miles of wire and 26,301 feet of aerial cable. There are 224 miles of pole line in the electric light and power distribution system of the two companies.

THE Southern Pacific Co. has been authorized by the California Railroad Commission to issue equipment trust certificates in the amount of $10,120,000, and to use the proceeds in acquiring equipment to cost $11,429,000. This equipment will consist of the following:

3181 box cars	$ 3,719,601
961 gondola cars	1,026,163
700 work cars	814,078
850 stock cars	850,350
400 automobile cars	573,600
240 flat cars	220,800
200 tank cars	273,500
45 caboose cars	60,660
5 gasoline motors	106,665
84 electric passenger coaches	1,160,369
114 locomotives	2,548,174
25 tenders	75,050
Total	$11,429,010

This equipment is to be used over the entire Southern Pacific system. This large order indicates the preparations that are being made to take care of the traffic.

THE California Railroad Commission has authorized the Pacific Eelctric Co. to issue bonds to the amount of $6,839,000, to provide funds for extensions and improvements to the Pacific Electric Railway, as follows:

Extensions and branches	$3,428,518.36
Additional main tracks	43,567.53
Tunnels, bridges, etc	444,609.81
Real estate	39,975.22
Stations, shops, etc	156,787.54
Light and power plants	216,962.27
Water and water rights	940.00
Rolling stock	1,554.911.23
Additions and betterments	699,410.08
Total	$6,585,682.04

The projected improvements cover the principal lines of the Pacific Electric Railway Co. in southern California. The larger items enumerated in the application are as follows:

Improvements to Covena-San Dimas line	$ 53,000
Riverside-Colton-San Bernardino line	408,000
Glendale-Burbank line	53,000
Lankershim extension	236,000
Magnolia-avenue line	76,000
Pasadena city lines	97,000
San Bernardino extension	1,424,000
Van Nuys extension	42,000
Dominguez Townsite line	46,000
San Pedro-Hermosillo line	42,000
Torrance line	42,000
Van Nuys extension	42,000
Van Nuys-San Fernando line	213,000
Van Nuys-Owensmouth	215,000
Watts-Homeward line	108,000
Santa Ana-Orange line	64,000
South Pasadena cut-off	159,000
Tunnels, bridges, etc	444,000
Stations, shops, etc	156,000
Redlands-San Bernardino line	43,000
San Bernardino-Highlands line	105,000
Alamitos-Bay City line	24,000
Covina line	34,000
Gardena-Strawberry Park line	17,000
Hawthorne-El Segundo line	161,000
Pasadena local lines	40,000
Santa Ana line	76,000
Uplands-San Antonio line	25,000
Del Rey-Redondo line	87,000
Hermosa Beach line	44,000
Redondo Beach	175,000
Whittier-La Habra line	105,000

It is evident that electric transportation development has by no means culminated.

Generated on 2024-09-30 00:13 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Engineers' Note Book

Measuring the Flow of Air in Pipes*

By G. G. CREWSON

Some time ago, in a large mill where it was desired to make a proper cost distribution for the compressed air supplied to the various departments, the problem arose of measuring the air velocities in the different pipes. These velocities varied from 500 to 5000 ft. per minute with the air under a pressure of about 80 lb. per sq. in. and as dry as can be obtained in a large compressed-air system.

The pitot tube was considered to be the most convenient device for the purpose, and in order to determine the accuracy of the various arrangements, an apparatus was fitted up as shown in Fig. 1. The air was admitted to the large tank *A* through the pipe *B* and escaped through an orifice at *C*. Pressure gauges showed the pressures at the pitot-tube connection *E* and at the discharge orifice. Different-sized orifices were used in each case, these having previously been calibrated and the flow per minute under a tank pressure of 80 lb. per sq. in. was determined as follows:

Diameter of orifice, inch	Cu. ft. of air per min.
3/8	191
1/2	340
5/8	532
3/4	765

The pitot tube was inserted in the supply pipe at a point not less than 20 diameters away from the tank or from any bend or fitting in the pipe that would tend to cause eddy currents. Various sizes of supply pipes were also used.

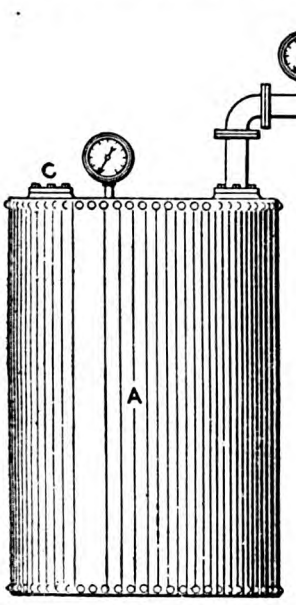


FIG. 1. ARRANGEMENT OF APPARATUS.

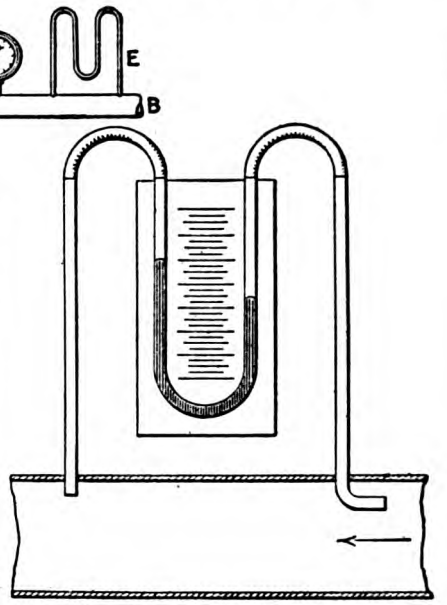


FIG. 2. FIRST FORM OF PITOT TUBE USED.

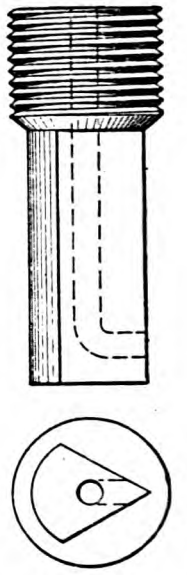


FIG. 3. FINAL FORM OF VELOCITY TUBE.

The two sides of the pitot tube led to an ordinary form of U-tube, and at first this feature was troublesome as difficulty was experienced in maintaining tight connections. This was finally overcome to a large extent by making a special form of U-tube with well packed connections and leads of 1/8-in. pipe.

The form of pitot tube first employed was but a piece of 1/8-in. grass pipe bent as shown in Fig. 2. The pressure side extended slightly inside the wall of the supply pipe.

*Abstract from *Compressed Air Magazine*, December 1912.

Generated on 2024-09-30 00:12 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

This form proved very unsatisfactory, giving varying results for the same conditions.

The next change was to make the velocity tube a straight pipe instead of a bent one. This projected directly into the supply pipe and was plugged at the end with a ⅛-in. hole drilled in the side facing the flow. The results in this case were but little better than before. The opening was then changed to 1/16 in., without materially affecting the observations.

Many modifications were made in the form of pitot tube used until the one shown in Fig. 3 was adopted. This tube was brass, turned and threaded to correspond to a ⅛-in. standard pipe to the point where it screws inside of the air pipe. Within the air pipe it has the form of a wedge with a knife-edge, the edge facing the flow, hence offering little resistance. The opening through the tube and the outlet facing the flow were 1/16 in. diameter.

These tubes were made in a number of different lengths for different sizes of pipe in order that the opening at the edge might always be near the centre of the pipe. The pressure side of the pitot tube was also found to give better results if it did not extend into the tube, but was just flush with the inside.

With this arrangement very accurate results were obtained. At one time, with velocities ranging from 500 to 5000 ft. per minute and in pipes from ¾ to 2 in. diameter, an average of 50 observations showed, when the velocity was calculated by the formula $V = \sqrt{2gh}$, an average error of less than one-half of 1% and a maximum error in a single observation of less than 2 per cent.

As explained, this arrangement was first used with an ordinary U-tube, but as this can give instantaneous readings only, and in many cases the flow to be measured was very irregular, a recording differential-pressure gauge was substituted. By this means records could be kept of the flow of air to any department over any length of time. Line leakages were also quickly detected by means of this record.

For pipes of 1¼ in. diameter and larger, the brass velocity tube was screwed directly into the wall of the pipe, but for smaller sizes standard tees were used, the upper branch being plugged and the plug tapped to admit the pressure and velocity tubes. The tee was then filled with lead and drilled to correspond with the diameter of the pipe with which it was to be used.

In applying this arrangement to an air-line, two conditions must be met in the connection leading to the U-tube: First, all connections must be absolutely tight. Any leakage, particularly on the velocity side, due to the small opening, will introduce a large error. Every joint should be carefully tested with a soap solution for leakage, and if a bubble is observed the joint should be made tighter. The second condition is to have the connections come from the top of the air-pipe or, if from the side, have them pitched up at first so as to drain any entrapped water back into the air pipe. If these two conditions are observed, the U-tube or differential-pressure gauge may be placed at some distance from the tube connections.

Hints on Practice

Corliss Governor Troubles

By F. C. HOLLY

When putting a new governor in service or having trouble with an old one, knowing where trouble is most likely to be found enables the engineer to reason quickly from the visible effect in the engine to the cause at the governor.

Probably the most frequent trouble in governors is binding in the governor-rod bearings, because the pins are too short; when the nut and washer are drawn up tight, side-binding results. This will cause a variation of engine speed in proportion to the friction induced, and a little friction will cause a noticeable variation at the switchboard; excessive binding will cause severe racing. This fault applies to the governor connections proper and to the cam-level connections. The remedy is to adjust every rod so that it can be freely moved sideways on the pin.

In one instance, several years ago, an expert made a trip of 300 miles and back to loosen one little nut on one of the governor pins, this being all that was necessary to cure a bad regulating trouble. The engine was in a municipal lighting plant, and at least one of the engineers was experienced in Corliss-engine operation.

The practice of placing the knock-off cam

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

lever bearing between the steam arm and the double arm, thus exposing it to a side thrust from each, is fundamentally wrong. The knock-off cam should operate on a separate flanged bearing.

Also important are the set-screws or keys, if any, in the governor gears. Serious accidents have occurred from these gears working loose on their shafts. On one occasion an erector installed and started an engine, and left it in charge of the regular attendant for a few moments. When he returned to the plant he found the engine racing badly. An investigation showed that the governor-driving gear was alternately slipping and catching on the shaft. The set-screw had not been properly tightened. Inspecting the governor gears and pulley occasionally is advisable.

Racing Causes.—Sometimes, under extreme variations of load, and even under less exacting conditions, a stiff governor will allow the engine to race. This is often due to too low speed in the governor, and is corrected by decreasing the size of the governor pulley and by adding weight to the governor until the engine picks up its normal speed. The governor can be weighted by hanging small weights on temporary wire hooks to the projecting yoke of the governor, afterward weighing them, and adding the equivalent weight permanently to the governor in whatever form its design best allows.

Before doing this, one should make sure there is no undue friction in the governor parts. This may be determined by removing the weights and balls and disconnecting the valve-gear, and seeing if the arms, after being raised as high as they will go, drop freely of their own accord. If on moving them up and down no binding or sticking is evident, there is no undue friction.

Dashpot Oil.—A trouble every engineer experiences is that of oil getting low in the governor dashpot. This should be the first place to look for the cause of a racing engine; but much valuable time is often lost investigating other possible causes before looking to this most likely and obvious one. To make up for evaporation, a little oil should be added to the dashpot occasionally. When all governor parts are properly adjusted to eliminate friction, and all bolts, set-screws, and keys are tight, the possibility of trouble is narrowed down to slipping belts or to the possibility of broken parts.

That all possible friction must be eliminated may seem unimportant, but cannot be too strongly emphasized.

Counterweight Required.—A leading pumping-engine builder contracted to furnish a high-duty pumping engine. The specifications required a governor capable of regulating the engine to a fixed speed. Previous to this contract no such regulating attachment had ever been furnished by this company, and none of the engineering force was familiar with governor design. However, a governor was made and applied. When the engine was started, and the governor put into commission, only the prompt action of the engineer in stopping the engine prevented a wreck. A more cautious trial was made, and showed that the governor would lengthen the cut-off to the running-away point, and then go to the other extreme and shut the engine down.

Throughout the following months experiments were tried. Belt transmission was changed to gear drive and back again. Speeds were altered, and cam attachments applied and taken off again; the best of the oldest engineers of the company exercised their wits on the problem to no avail.

Extension rods ran from the governor to the valve-gear 25 ft. above, transmitting the motion of the governor arm through bell cranks and shafting. Hundreds of dollars were spent, to say nothing of the loss of time and prestige, before someone thought to counterbalance the weight of these rods and cranks, and eliminate the friction from various pins and shaft bearings. Although these same pins and bearings were originally erected in a manner to satisfy all ordinary mechanical requirements, they were not perfect enough for governor work, a fact a good governor man could have pointed out in a few moments.—*Power.*

To DRILL chilled cast iron, first draw the chill. This is done by laying the piece on the forge, covering the spot to be drilled with sulphur, and working the bellows slowly until the sulphur is burned off. Then proceed with the drilling.

A GOOD all-round aluminum mixture is an alloy containing 92% of aluminum and 8% of copper. This mixture casts well, does not crystallize in service or crack in the mold, but has a fair tensile strength.

Generated on 2024-09-30 00:11 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Book Reviews

ELECTRIC FURNACES IN THE IRON AND STEEL INDUSTRY. By W. Rodenhauser and I. Schoenawa. P. 404. Index. John Wiley & Sons, New York. For sale by the *Mining and Scientific Press*, San Francisco. Price $3.50.

The cheap electric power available throughout the greater portion of the Pacific coast states makes this book of special interest to engineers and manufacturers in this section. The experiments at Heroult have been watched with great interest, and the authors have given an admirable analysis of the results that have been obtained thus far. Characteristics of all known types of electric furnace embraced under the general title are given with a description of their design and operation, including both American and European practice and development. The electric furnace possesses one prime advantage over others, in that it permits close regulation of temperature, a vital factor in the manufacture of steel, especially in the higher grades. Cheap current is essential to large operations, however, and the authors, in due appreciation of the importance of this fact, have dwelt exhaustively upon the economic side of the question. Tabulations of operating costs with current at various prices have been carefully prepared and constitute one of the most interesting features of the book. The electrical, metallurgical, and chemical phases of the subject are discussed with the thoroughness of the European engineer. It is believed that ultimately the electric furnace will replace the old time crucible for the manufacture of high-grade steel. Results achieved in the manufacture of rails would indicate that this is also a field in which conditions are favorable to electricity. As a whole, this book is exceptionally comprehensive and will well repay careful study, especially by engineers on the Pacific Coast.

PRACTICAL LOCOMOTIVE OPERATING. By Clarence Roberts and Russell M. Smith. P. 274. Index. J. B. Lippincott & Co., Philadelphia. For sale by the *Mining and Scientific Press*, San Francisco. Price $2.

Books without number have been written for the engineer and scientist. Opinions have often been expressed that there have been altogether too many. There is an idea in the minds of many people that mechanics and operators are not readers, and that the five o'clock whistle is the event of supreme interest of the day. There are signs of an awakening among thinking men, however. Writers on technical subjects are commencing to realize that the mechanic has ambitions for self improvement that are no less keen than those of the engineer. The success of the better class of correspondence schools is striking evidence of the truth of this statement. Many of the universities are conducting extension courses in order to bring the opportunity to obtain an education within the reach of all. Mr. Roberts is assistant road foreman of and Mr. Smith air-brake instructor for the Pennsylvania railroad and are therefore in a position to speak with authority on the subject upon which they have written. No attempt has been made to go into the technology of design. The book has been prepared for locomotive drivers and firemen who are necessarily concerned only with the finished product. Such mathematical formulae as have been given are shown in their simplest form and require no more than a knowledge of arithmetic to be understood and used. The practical use and characteristics of the mechanism of the locomotive in all of its present-day types occupy the major part of the text. Chapters leading up to the general subject include a discussion of elementary mechanics, fuels, and steam. A chapter is also given to boiler and safety-appliance law, qualifications, and responsibilities. This book should find a place on the shelves of all railroad libraries and the companies would find it to their advantage to encourage its use among their operating department employees.

CHARACTERISTICS AND LIMITATIONS OF THE SERIES TRANSFORMER, by H. R. Woodrow and A. R. Anderson, has just been issued by the Engineering Experiment Station of the University of Illinois as Bulletin 61. In determining the action of electrical circuits of high voltage or of heavy currents, it is often desirable to connect instruments into a circuit which is not metallically connected with the main circuit, but which is so arranged as to carry a current bearing a known relation to the current of the main circuit. These conditions are met in practice by the use of the 'series' or 'current' transformer. Bulletin No. 61 presents the results of a theoretical study of such transformers.

Generated on 2024-09-30 00:08 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Industrial Progress

Lining Irrigation Ditches in Hawaii

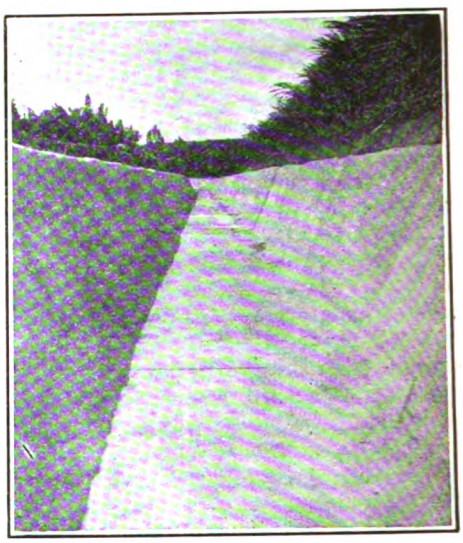
A new field for cement-gun work has been developed by Alexander & Baldwin, Ltd., of Honolulu, in connection with irrigation work in the island of Maui. The irrigation ditches in question were first lined with a light poultry-mesh of 1½-in. aperture, and a mixture of 1 part of cement and 3 parts of beach sand was then applied by the cement gun. The work progressed at a good rate, one gun averaging about 100 lineal feet per day on a ditch 6 ft. wide, with 6-ft. walls, and the costs were very satisfactory.

They also had three tunnels to construct, 250 ft., 400 ft., and 750 ft. long respectively, all of which were lined in the same manner, and the interesting fact developed that they applied the material through an iron delivery-pipe 850 ft. from the cement gun itself. This of course increased the friction and decreased the output, but it worked satisfactorily and saved handling the equipment inside the tunnel.

Something over 2 miles of open ditch has been completed and two new ditches are now being constructed, 4½ and 10 miles long respectively, a large part of which consists of tunnels from 800 to 3000 ft. long.

In a report of the work, they mention the great saving of water otherwise lost by seepage, and the reduction of friction, which makes it possible to increase materially the amount of water carried and reduces the grade. The report also calls particular attention to the imperviousness of the 'Gunite' lining.

APPLYING THE GUNITE.



THE COMPLETED DITCH.

German Profits in Gas-Engine Manufacture

The report just issued by the Deutz Gas Engine Works, Cologne-Deutz, one of the largest German gas-engine companies, discloses a net profit of $772,000 against $629,000 last year, and proposes a dividend of 9%, against 8½%. The capital is $5,236,000 against $4,689,000. The turnover of the German works was $4,665,000, against $4,117,000. The foreign trade increased by $330,000 against an increase the previous year of $367,000. Complaints are made regarding the continual increase in taxation, there being an advance last year of 18%. The amount paid in taxation for assistance to the ordinary workman, as for example insurance, now amounts to about 10% of the net profits of the concern. So far as it is at present possible to judge, the current year should prove satisfactory. The orders on the books at the commencement amounted to $1,978,000, against $1,593,000 at the beginning of the past year.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Engineering News

Railways

San Francisco.—The California Railroad Commission reports the following: The Southern California Edison Co. has applied for authority to purchase from the Pacific Electric Railway Co. its electric distributing system at Gardena, Moneta, Clifton, and Redondo beach in Los Angeles county at a price of $17,500. The Pacific Electric Co. has joined in the application.——The Beaumont Gas Power Co. of Riverside county has applied for authority to issue a promissory note to the amount of $5000 to refund existing indebtedness.——The Southern Pacific Co. has applied for authority to issue equipment trust certificates to the amount of $10,120,000 for purchasing equipment.——A decision has been rendered authorizing the Big Four Electric Railway Co. to issue capital stock to the amount of $400,000. The proceeds of sale of said stock are to be used for construction of an electric line from Tulare to Porterville and from Tulare to Visalia.——Authority has been granted the Los Gatos Telephone Co. to issue stock to the amount of $15,000 to provide funds for the erection of a new building in Los Gatos, refunding a promissory note for $1000 and for building new aerial cables.——J. R. Anderson has applied for a certificate of public convenience and necessity to operate under a gas franchise in Oakdale, Stanilaus county.——The Pit River Power Co. has applied for a certificate of public convenience and necessity to supply power to the northeast portion of Shasta, Modoc, and Lassen counties.——It is stated that the Southern Pacific Co. is preparing plans for the immediate commencement of work on a new electric line between San Mateo and San Jose.——At the annual meeting of the Oakland, Antioch & Eastern Railroad, W. Arnstein, S. F. Naphtaly, Henry T. Scott, H. C. Breeden, A. W. Malty, H. A. Mitchell, and Burk Corbet were elected directors.——The board of supervisors has passed an ordinance to print ordering the construction of the westerly extension of the Geary street municipal railroad from its present terminus at 33rd avenue to the ocean beach.——The F. M. Smith interests at Oakland have been placed in the hands of trustees.

Panama-Pacific Exposition

The building and grounds committee has opened bids for the construction of the agricultural palace. The lowest bidder was Lange & Bergstrom, who offered to construct the building for $253,523. The lowest bidder on the plumbing was the Peterson James Co., whose price was $22,962. At a meeting of the board of directors the following were elected officers for the coming year: Charles C. Moore, president; William H. Crocker, R. B. Hale, I. W. Hellman, Jr., M. H. de Young, Leon Sloss, and James Rolph, Jr., vice-presidents in the order named; Rudolph J. Taussig, secretary, and A. W. Foster, treasurer. Members of the executive committee were also reëlected, and are as follows: Charles C. Moore, Frank L. Brown, M. H. de Young, Alfred Esberg, William H. Crocker, Curtis H. Lindley, A. W. Foster, R. B. Hale, James McNab, I. W. Hellman, Jr., and Leon Sloss.——Contract for piling and foundation work for the transportation building has been awarded to Healy Tibbitts Con. Co. The contract will amount to about $40,000, and specifies 24.3c. per lineal foot for driving the piling, the total amount of piling being 205 feet.——Arrangements are being made to construct ten miles of standard-gauge railroad on the exposition grounds for the purpose of transporting exhibits and building material.——The Santa Fé Railroad Co., which was granted a concession to reproduce the Grand Canyon of Arizona, has commenced construction work. The total amount to be expended for this purpose is $250,000.——A temporary plank road has been built through the exposition grounds in order to make it possible for visitors to go over the site from Van Ness avenue to the Presidio.——An automatic moving-picture machine has been placed on the roof of the service building for the purpose of recording the construction of the machinery palace. The camera will take a set of pictures every five minutes, or 96 pictures for each working day. When the building is completed moving pictures will show it as being constructed in a few minutes.——The arch trusses for the machinery building are being put in place. There are 125 trusses, each weighing four tons. Over 7,000,000 ft. of lumber has been used for their construction. Six thousand applications for concessions have been received by the director of concessions.

Generated on 2024-09-30 00:15 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Streets and Roads

Sausalito.—An issue of $100,000 of bonds has been approved by the voters for the improvement of Sausalito roads and streets.

Sacramento. — The California Highway Commission has awarded a contract to Considine & Bates Co. for the construction of section B, route 4, division 3, Stanislaus county, of the state highway. Its bid was $32,389.

Specifications and the routes of five sections of the state highway system in five different counties of the state, designated and surveyed some time ago by the Highway Commission, were approved by the advisory board of the State Department of Engineering recently, as follows: Stanislaus county, from Turlock to Ceres, oiled concrete; Yuba county, from Morrison's Crossing to Marysville, repairing bridges; San Mateo county, from San Mateo to Beresford, two miles, macadam concrete; Santa Clara county, from San Jose to Edenvale, four and one-half miles, macadam asphalt; Ventura county, from southern boundary to Newbury Park, eight miles, oiled concrete.

Four contracts were let for work as follows: Richard Keating & Sons, San Francisco, $55,584, 12.95 miles, concrete base, bituminous top, from Edendale to Morgan's Hill, in Santa Clara county. Considine & Bates, Los Angeles, $22,389, seven miles oiled concrete, from Modesto to northern boundary in Stanislaus county. David Sawyer and Charles White, $53,313, grading and macadam, from Ukiah to Forsyth creek, in Mendocino county. S. P. Boyle, $41,720, 3.3 miles of asphaltum concrete macadam, from Redwood City to southern line of San Mateo county.

Roseville.—An issue of $20,000 in bonds to provide funds for constructing a section of state highway through the city has been approved by the voters.

Nevada City.—A proposal has been submitted to the board of supervisors by A. D. Foote, of Grass Valley, in which Mr. Foote proposes to build a road and bridge from the Delhi mine to the middle Yuba river canyon. This road will cut off 13 miles of the distance to Alleghany.

Los Angeles.—The board of supervisors has instructed the district attorney to draft an ordinance to protect county roads from being cut for the purpose of laying pipes. No permits for this purpose will be issued in future unless approved by F. H. Joyner, chief county highway engineer.

Colfax, Washington.—W. J. Roberts, state highway commissioner, has submitted a statement to the county commission showing that Whitman county will have available $76,650 for permanent highway improvements. As two contracts have already been let for highway work, J. H. Milton, county engineer, estimates that there will be $25,000 available for additional work.

Harrington, Washington.—The Spokane Asphalt Macadam Co. has commenced the execution of its contract for macadamizing the first seven miles of the Harrington-Davenport state road. H. E. Tuttle is in charge of operations. A 16-ton gasoline road roller, rock-crushing plant, drills, and a steam traction engine will be used.

Wenatchee, Washington.—Bids were opened for wood-block paving on Wenatchee avenue as follows: J. J. McEnery, $102,455; Washington Paving Co. of Tacoma, $102,864; Hassam Paving Co. of Spokane, $103,487.

Spokane.—Plans have been prepared by Morton Macartney, city engineer, for improving Trenton avenue from Division street east. The approximate cost will be $56,900, divided into three districts; the first extending from Division to Grant street, at a cost of $22,000; the second from Grant street to West Trent avenue bridge, $6600; and the third between the East and West Trent avenue bridges, $28,300.——The county commissioners have passed a resolution favoring the building of a permanent highway five miles long between Waverly and Spring valley. The county engineer has been instructed to make preliminary surveys at once.

Salt Lake City.—The Utah Marble & Construction Co. is contemplating equipment of quarries and finishing plant for developing the marble deposits of this state. A. F. Judd is president and R. B. Garff is vice-president. It is stated that $200,000 will be spent at once for machinery and equipment.

Power, Gas, and Electricity

San Francisco.—The California Railroad Commission reports as follows: The Pacific Gas & Electric Co. has been authorized to spend $500,000 of its bond issue of $5,000,000 for enlarging the canal on the Bear River Canal Development project in Placer county to provide for a flow of 350 second feet. The

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

present capacity of the canal is 50 second feet.——A certificate of public necessity and convenience has been granted to J. A. Anderson for the operation of a gas plant under a franchise from the city of Oakdale.——The Empire Water Co. of San Benardino has applied for authority to issue $200,000 in bonds to provide funds for construction of a hydroelectric power plant.——R. E. Cavanaugh has applied for permission to sell his electric light plant at Edgewood, Siskiyou county to the California-Oregon Power Co. for $10,000. The California-Oregon Power Co. has joined in the application.——A. Woodside has asked permission of the Board of Harbor Commissioners to wire pier 42 for electricity to be used for supplying power for the operation of a conveyor and hoist. As steam has always been used for this purpose heretofore, Mr. Woodside's experiment will be watched with a great deal of interest. The initial trial will be made with a 20-hp. motor for the hoist and a 5-hp. motor for the conveyor. It is expected that the Pacific Mail and the San Francisco & Portland S.S. lines will ultimately equip piers 40, 42, and 44 with electrically operated freight-handling apparatus.

Los Angeles.—The Board of Public Utilities has recommended to the city council the establishment of the following rates for electric lighting and power for the ensuing fiscal year: For 11 kw. hours or less consumed in any one month, 6.5c. per kw.; for more than 11 kw. hours as follows:

First	100	kwh., 6.00c. per kwh.
Next	150	kwh., 5.75c. per kwh.
Next	250	kwh., 5.25c. per kwh.
Next	500	kwh., 4.50c. per kwh.
Next	1000	kwh., 3.50c., per kwh.
Next	1000	kwh., 2.60c. per kwh.
Over	3000	kwh., 2.30c. per kwh.
First	100	kwh. in month, 5.0c. per kwh.
Next	200	kwh. in month, 4.5c. per kwh.
Next	200	kwh. in month, 4.0c. per kwh.
Next	500	kwh. in month, 3.0c. per kwh.
Next	500	kwh. in month, 2.5c. per kwh.
Next	500	kwh. in month, 2.0c. per kwh.
Next	1000	kwh. in month, 1.8c. per kwh.
Over	3000	kwh. in month, 1.2c. per kwh.

The Aqueduct Power Bureau has issued a statement of the financial condition of the department up to March 1, of which the following is an abstract: Revenues, $4,122,018, which sum is made up of power bonds of the election of 1910 to the amount of $3,500,000, appropriations from the general fund for preliminary investigation before the bonds were issued, $22,018, and due from the aqueduct bureau from the joint waterway construction fund, $600,000. Expenditures from this revenue have amounted to $3,179,286, as follows: Preliminary engineering and organization, $32,416; general expense, incurred since September 11, 1911, in the supervision of the work of construction, $112,409; San Francisco power plant No. 1, $619,925; San Francisco power plant No. 2, $1,158,408; tunnel between power plant No. 2 and the first aqueduct tunnel, $92,796; auxiliary construction expense pertaining to power plants No. 1 and No. 2 and the tunnel connecting No. 2 with the first aqueduct tunnel, $597,587; transmission system, $220,520; material on hand and not yet issued, $345,224.

Redlands.—The Southern Sierras Power Co. is conducting an examination to determine the most feasible route for bringing its high power line into this city. It is expected that the line will be brought in on San Bernardino avenue from the San Bernardino-Riverside line and up that avenue to Judson street and beyond.

Bellingham, Washington.—The Public Service Commission has entered an order fixing the value of the Whatcom Railway & Light Co. Bellingham properties at $2,150,000, divided as follows: railway system, $1,000,000; light and power system, $750,000; and gas system, $300,000.

Klamath Falls, Ore.—The municipal authorities are negotiating with the U. S. Reclamation Service to obtain the use of a portion of the water developed by the Klamath Falls irrigation project in order to generate power for municipal purposes.

Fernie, B. C.—The voters of Fernie have approved a project to expend $10,000 for the purpose of extending the municipal electric light system.

Provo, Utah.—J. A. Jones has commenced the erection of a gas plant.

Denver, Colorado.—The Colorado Power Co. has been incorporated with an authorized capital stock of $20,000,000. This company will take over and operate the properties of the Central Colorado Power Co., the Leadville Light & Power Co., and the Salida Light & Power Co. An extensive program of development, including the purchase of other power plants, will be undertaken.

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Irrigation and Water Supply

San Francisco.—At the annual meeting of the Spring Valley Water Co., the directors and officers now serving were reëlected.——Natomas Con. has contracted with A. S. Bent, of Los Angeles, for 10 miles of concrete pipe ranging from 10 to 24-in. diameter. This is for the first unit of the company's system.——A. J. Rich & Co. have purchased for the account of the Solano Irrigated Farms, at a cost said to be approximately $1,000,000, the entire reclamation district No. 526, immediately north of and adjoining Rio Vista opposite Ryer island. Work enlarging levees has already commenced.

Oroville.—It is stated that the Pacific Gas & Electric Co. is contemplating tunneling the mountain at Colgate for the purpose of developing additional water-supply.

Woodland.—The Yolo Water & Power Co., R. H. Beamer, general manager, will expend $200,000 at this point on improvements. The ditch to the state farm has been lined with concrete and has resulted in greatly increasing the quantity of water delivered by preventing the seepage loss.

Montague.—The Big Springs Water Co. has been incorporated by land-owners near Big Springs for the purpose of developing water for irrigation by means of artesian wells.

Riverside.—A new bond election has been called for May 19, for $1,160,000 for purchase of the water works, plants, and improvements. Bonds will bear 5% interest. A previous issue was voted, but the interest being 4½%, the bonds were unsalable.

Sacramento.—State Reclamation Board is considering the application of the Sutter Basin Improvement Co., of which W. E. Gerber is general manager, for the formation of an irrigation district.——The John D. Spreckels Ranch Co. has been incorporated with an authorized capital stock of $2,500,000. It is stated that this company has acquired 15,000 acres of land in Butte and Glenn counties, between Nelson and Butte City. The directors are: W. I. Brobeck of Berkeley, Edward Schwab, F. B. Lorigan, and W. R. Lowery of San Francisco, and A. L. Whittle of Mill Valley.

Pendleton, Oregon.—The city council has approved the plan of the water commission to bring water for municipal purposes from Thorne hollow. Bonds to the amount of $200,000 to provide funds for this project have been offered for sale.

San Jacinto.—The pipe-line project of the San Jacinto Land company, west of Hemet, is nearly completed. The cost is approximately $20,000, and 900 acres of land will be placed under irrigation. The main is 34 and 26 in., concrete lined with laterals 16 and 14 in. The total length is 27,000 feet.

Klamath Falls, Oregon.—The U. S. Reclamation Service will commence construction work to enlarge Adams canal on the north side of Tule lake. John Yaden and Howard Cleveland are the resident engineers.

Endicott, Washington.—The city council has retained H. C. Green & Co., consulting engineers, to prepare plans and specifications for a municipal water plant, and a bond issue will be submitted to the voters at an early date to provide about $10,000 for doing this work.

North Yakima, Washington.—The legality of the $25,000 bond issue for a municipal irrigation system has been approved. Of this amount, $5000 will be appropriated for purchasing right-of-way and engineering and the balance will be used for construction work. This system will furnish water from Naches and Cowiche ditch under low pressure to 851 lots in the southwest portions of the state.——The Public Service Commission has ordered the Pacific Power & Light Co. to install betterments to improve water service: the betterments to include a concrete reservoir with two compartments and a capacity of 15,000,000 gal. for furnishing water to the city at 85 lb. pressure. All wood mains are to be repaired or replaced by steel conduit.

Provo, Utah.—The directors of the Provo Reservoir company have adopted resolutions providing for the issue of $250,000 in 6% bonds for the purpose of providing funds for the construction of canals, reservoirs, and other extensions and improvements.

Logan, Utah.—A report has been submitted to the city commission by George W. Lindquist, city commissioner, and Mr. Humphreys, city engineer, embodying a plan for the construction of a water filtration plant at a cost of $50,000. As an alternative, it is proposed to extend the city mains to DeWitt spring and install either a 28,000-ft. wood-stave pipe-line at a cost of $65,000 or a Matheson-joint pipe-line at a cost of $107,000.

Ogden, Utah.—An agreement has been made between the city and the Ogden River Reservoir company providing for the joint construction of a dam and reservoir in South Fork canyon at a cost of $350,000.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Miscellaneous Engineering Construction

San Francisco.—The following bids have been received by the Board of Works for the construction of the roadbed for the Geary street municipal railroad from 33rd avenue to the great highway, the route being along 33rd avenue, Balboa street, 45th avenue, Cabrillo to the Beach, a distance of 7400 feet. The Healy Tibbitts Construction Co. put in the lowest bid, $34,450, this amount being less than half of the highest bid, $77,760, which was filed by Grant Smith & Co. The other bids were: T. H. Mullin, $35,900; F. E. Hillmer, $39,340; Mahoney Brothers, $44,710; Central California Construction Co., $47,540; F. Rolandi, $48,295; Gorrill Brothers, $51,187; Contra Costa Construction Co., $53,880.

The Pacific Fire Extinguisher Co. has been awarded the contract for furnishing and installing boilers, breeching, and piping for the Relief Home, on the Relief Home tract, at a cost of $12,863.—The contract for constructing a tank and tower for the Geary street carhouse, has been awarded to the Pacific Tank & Pipe Co., at a price of $1249.

A single leaf trunnion bascule bridge is to be built by the Santa Fe railway across Islais creek at Kentucky street, in accordance with plans that are to be approved by the Board of Public Works. A clear channel 95 ft. wide is to be maintained.——The State Board of Harbor Commissions has awarded contracts as follows:

The Pennsylvania Steel Co.: T-rail frogs for $3474.75; 6 by 11 tie-plates, $3630; girder rails, $87,000.

The United States Steel Products Co.: switches, $860.50; guard rails, $676.50; switch stands, $287.50; brace tie-plates, $2255; 65-lb. T-rails and splices, $21,842.50.

Eccles & Smith: 6 by 9 tie-plates, $4350.

H. B. Green: continuous rail joints at $5.65 apiece.

The Board of Public Works has let contract for building the Stockton street tunnel to Jacobson-Bade Co. for the sum of $337,000. The main office of the company is in Portland, Oregon, and C. E. Bade is president.

Oakland.—Plans and specifications have been prepared for dredging the estuary channel 30 ft. deep, in front of the quay wall. The channel is to be carried out to deep water which is to be dredged by the Federal Government. Harry Anderson is commissioner in charge of the work. A descriptive article covering Oakland harbor quay wall construction was published in the November 1912 issue.

San Rafael.—The city trustees have called for an election to authorize a bond issue of $115,000; providing for dredging the canal, $40,000, if the Federal Government provides a like amount; garbage incinerator, $25,000; municipal bath house, $25,000; street and sewer work, $25,000.

Berkeley.—At an election held at Berkeley the following bond issues were ratified by the voters: $475,000 for new sewers and $95,000 for a new fire house and equipment.

Napa.—The Board of Trustees has under discussion a bond issue to provide $13,000 for the construction of storm sewers and the purchase of an automobile fire engine.

Lodi.—A bridge across Mokelumne river at Victor, recently completed at a cost of $24,000, has been accepted by the Board of Supervisors. F. E. Quail is county surveyor.

Suisun.—The Northern Electric Railroad has asked for a grade crossing over the line of the Southern Pacific at Union avenue. It is believed that the application will be denied and that the Northern Electric Co. will be compelled to build a tunnel.

Chico.—The city trustees have under discussion a project to impose a special tax levy to provide funds for the construction of the municipal incinerating plant.

Redding.—It is stated that a special act of the legislature will be required before the city can proceed with the bond issue for the erection of the proposed bridge over the Sacramento river at this point as a link in the state highway.

Yreka. — The supervisors have adopted plans for a reinforced concrete bridge across the Sacramento river at Dunsmuir as a part of the state highway. The bridge will have a span of 380 or 400 ft. The estimated cost is $25,000.

Los Angeles.—A contract has been let to the Morcereau Bridge & Construction Co. for the construction of a municipal warehouse foundation in the rear of the proposed Mormon island channel wharf and for 3000 ft. of bulkhead along the south and east sides of slip 'A,' Wilmington, at a price of $9740.38.——The Board of Harbor Commissioners has approved plans for a transit shed 600 ft. long which is to be erected upon a section of the Wilmington wharf. The shed will be 100 ft. wide and will be served by a

Generated on 2024-09-30 00:09 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

four-track belt-line road connecting with the main line of the Southern Pacific Co.——A report by F. H. Joyner, chief county engineer, has been made recommending the purchase by the county of the aqueduct cement plant at Monolith.——The Standard American Dredging Co. has been allowed 60 days additional time in which to complete its contract for dredging the outer harbor adjacent to municipal dock No. 1 as recommended by S. A. Jubb, harbor engineer.——A contract has been let by the harbor commission to the Standard American Dredging Co. for dredging 11,300,000 cu. yd. for Mormon island channel and Wilmington basin and placing the dredged material in areas 'A,' 'B,' and 'C,' and slip No. 1. Their bid was 13¼c. per cubic yard for taking material from slip No. 1 and depositing it in areas 'A,' 'B,' and 'C.' The total contract price will amount to about $180,000, and the company has agreed to complete 150,000 cu. yd. of dredging and filling each month.——The Board of Public Works and the City Council have approved the revised specifications for the installation of a garbage disposal plant, and bids have been called for June 20.

Spokane, Washington.—The Northern Pacific Railroad has awarded a contract for regrading the line from Seattle to Bellingham and Sumas at a cost of between $4,000,000 and $5,000,000. The greater part of the work has been let to Coughren & Woldson, of Spokane.——It has been announced that the Spokane, Portland & Seattle Railroad Co. will construct freight terminals, shops, and yards at Overlook, near Wents station, west of the city of Spokane, as soon as rights-of-way can be settled. J. H. Young is president of the company.——The City Council has been petitioned to build new sewers on a number of streets and avenues.

Salt Lake City.—The City Commission has authorized the expenditure of $34,500 for paving and sewer improvements. Richard P. Morris is street commissioner.——Bids have been called for the construction of five reinforced-concrete bridges. Each bridge will cost approximately $1500.——The City Commission is planning to create the position of city sewer engineer, in view of the many complicated problems embodied in the plans for extensive sewer construction in this city. Steps are to be taken to call for a bond election of about $600,000 for new sewer construction.

Petroleum

San Francisco.—Statistics of California's production of crude oil in March 1913 give the yield as 7,986,407 bbl., being an increase over that of February by a daily average of 1101 bbl. In the more important fields, Midway produced in March 2,392,150 bbl., Sunset 486,300, and Coalinga 1,630,657, a total of 4,509,107 bbl. The total quantity of oil in stocks or surplus on March 31 was 48,156,980 bbl. The surplus on hand February 28 was 47,967,404 bbl., an increase of only 189,576 during March. Last year the surplus piled up at the rate of 500,000 bbl. per month.

The following table exhibits the condition of stocks in the various fields:

Fields.	Field stocks.	Pipe-line stocks.	Total.
Coalinga	490,209	2,595,368	3,085,377
Kern River....	495,400	29,453,693	29,949,083
Maricopa	241,837	594,647	836,484
Midway	631,250	1,567,372	2,198,622
McKittrick ...	85,363	916,477	1,001,840
Lost Hills Belridge	74,800	321,812	396,612
Santa Maria-Lompoc	320,840	497,333	818,173
Olinda-Brea-Puente	34,454	180,453	214,907
Salt Lake.....	111,836	39,409	151,245
Whittier	55,387	.....	55,387
Coyotes-La Habra	35,987	.....	35,987
Ventura	18,863	68,573	87,436
Newhall	2,492	.....	2,492
L. Angeles dist.	15,000	295,454	310,454
Outside of fields	.....	9,012,671	9,012,671
Totals	2,613,718	45,543,262	48,156,980

The Union Oil Co. has distributed dividend No. 20, making the total paid to stockholders $12,883,536. Sales for the past three months show an increase of 16% over the corresponding period of last year.——The Associated annual report for 1912 indicates that the year was not satisfactory in the fuel oil business owing to over-production. The company therefore reduced drilling and purchased.——The Standard Oil Co.'s gusher No. 16, on section 4, in the Lost Hills area, has been flowing 1200 bbl. of 36° oil from a depth of 1720 feet.

Naval officials at Washington fear that operations conducted on adjacent lands may deplete the stock of oil in naval reserves and are asking that some action be taken. It is

Generated on 2024-09-30 00:15 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

estimated that there is 200,000,000 bbl. of oil in the present reserves, but with the Navy being rapidly converted to the use of oil, future supplies become doubly important.

Bartelsville, Oklahoma.—The Cushing pool, which came in early in 1912, is attracting much attention, and there are now 150 wells down or drilling in the field. The oil runs 42 to 44°B., but the production is decreasing despite the new wells. Edge wells average 15 to 20 bbl. initial production; centre wells run 250 to 5000 bbl., and settle in 60 to 90 days.

Personal

H. J. CRAVEN is city engineer at Ogden, Utah.

H. K. OWENS, consulting engineer of Seattle, has returned from Panama.

G. A. WARING, irrigation engineer, has returned from Rio de Janeiro, Brazil, and is at Mayfield, California.

B. S. JOSSELYN has resigned his position as president of the Portland Railway Light & Power Company.

GEORGE S. BINCKLEY, consulting engineer, of Los Angeles, California, has removed his office to 511 Central building.

N. D. MOORE, assistant chief engineer for the Pacific Coast Co., at Seattle, has returned from an extensive Alaskan trip.

P. F. KENNEDY, assistant city engineer at Spokane, Washington, has resigned his position to engage in consulting work.

FLOYD G. DESSERY, consulting civil and hydraulic engineer, of Los Angeles, has removed his offices to 511 Central building.

HAVILAND, DOZIER & TIBBETTS have been appointed consulting engineers for the Richmond, California, municipal water district.

L. F. WARNER has resigned his position as city engineer at Auburn, California, to become county surveyor to succeed R. G. Evenden.

R. E. COLLIER has been appointed water engineer for Salt Lake City, Utah, to succeed SYLVESTER Q. CANNON, who was recently appointed city engineer.

THOMAS W. WALSH has been made division superintendent for the Oregon-Washington Railroad & Navigation Co., with headquarters at La Grande, Oregon.

J. R. CHRISTIE has resigned his position as a member of the Municipal Board of Electricity for the city of Alameda, California. Herman Krusi has been appointed to fill the vacancy.

ALLEN C. WRIGHT, manager for the Petroleum Rectifying Co., of San Francisco, died recently at Adler Sanitarium as a result of an operation for appendicitis.

F. S. BURROUGHS, chief engineer for the Washington State Public Service Commission, has been giving expert testimony in the Spokane, Washington, gas rate case.

LINDSAY HUDSON, for three years civil engineer for the Sacramento Valley Irrigation Co., has resigned his position to engage in similar work at San Luis Obispo, California.

W. A. DOBLE, chief engineer of the Pelton Water Wheel Co., will leave for New York on May 1 to attend the excursion of the American Society of Mechanical Engineers to Germany.

CALEB TURNER, state engineer for Utah, W. D. BEERS, and JOSEPH JENSEN have been inspecting the bedrock and dam-site for the Ogden River Reservoir Co. in South Fork canyon, Utah.

THOMAS BERRY and WILHELM WINTERHALTER have formed a partnership for the purpose of engaging in consulting civil and agricultural engineering practice, with offices at 1219 Hearst building, San Francisco.

R. A. THOMPSON has been appointed as member of the board of engineers to place a physical valuation on the railroads of the United States for the Interstate Commerce Commission. The other members are W. D. PENCE, J. S. WORLEY, H. M. JONES, and E. F. WENDT.

Society Meetings

THE PACIFIC NORTHWEST SOCIETY OF ENGINEERS, with headquarters at Seattle, Washington, will hold its annual convention on August 1 and 2.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES held the third annual meeting at the University of California, at Berkeley, on April 10, 11, and 12.

THE UTAH SOCIETY OF ENGINEERS held its annual election and banquet on Friday, April 11. H. B. McMaster, of Youngstown, Ohio, delivered an address upon the metal-lath industry of the United States with special reference to fireproofing material and fireproof construction. The students and faculty of the University of Utah were invited to attend the lecture.

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Catalogues Received

H. M. Byllesby & Co., engineers, of Chicago, have issued department bulletin No. 2, dealing with their department of examinations and reports.

The Rix Compressed Air & Drill Co., 219 Spear street, San Francisco, has issued a pamphlet illustrating and describing the Gardner-Rix vertical high-speed air-compressor.

The General Electric Co., Schenectady, New York, has published bulletin A-4092, describing the Thompson watthour meter; bulletin A-4087, direct-current motor starting panels for heavy service.

The Southern California Edison Co. has published Vol. 2, No. 9, 'Edison Current Topics,' an exceptionally interesting number, containing several technical articles as well as matters of local interest.

The Green Fuel-Economizer Co., Matteawan, New York, has issued a pamphlet on the best proportion of boiler and economizer surface. A number of curves, charts, and formulas are given. Charles C. Moore & Co., of San Francisco, are Coast representatives.

The Chicago Pneumatic Tool Co., of Chicago, has issued bulletin No. 138, descriptive of the Chicago Giant rock-drill mountings. Bulletin No. 137 describes the Chicago Giant rock-drill, tappet type, and bulletin No. 139 describes appurtenances for rock-drills. N. E. Otterson, of San Francisco, is Pacific Coast agent.

The American Well Works, Aurora, Illinois, has issued bulletin No. 127 on economical irrigation by pumping. The catalogue is copiously illustrated and contains interesting data of value to engineers concerning irrigation. The California Hydraulic Engineering & Supply Co., of San Francisco, is agent for California.

The Pacific Flush-Tank Co., 108 South La Salle street, Chicago, has issued a catalogue on the automatic air-lock apparatus for flushing sewers and handling sewage. This is an exceptionally attractive publication and contains descriptive matter and operating data concerning the Miller siphon and other accessories that will be of special interest to sanitary engineers.

The Lyons-Atlas Co., Indianapolis, has issued bulletin No. 201, descriptive of the Atlas crude-oil engine, Diesel type. This bulletin is unusually complete, and contains in addition to the usual descriptive matter, information and data of interest to engineers on the operation of this new type of prime mover. H. F. Lyons & Co., of San Francisco, are the Pacific Coast agents.

The Raymond Concrete Pile Co., of New York and Chicago, has issued a catalogue on the Raymond concrete pile. This catalogue is exceptionally complete and goes into much detail with regard to construction, application, and use of their type of concrete pile. The San Francisco office is at 507 Mission street.

Commercial Paragraphs

The Standard Engineering Co. of Seattle was recently awarded a contract for installing a lighting system at Boise, Idaho.

The Tacoma Wood Pipe Co. has been awarded a contract for about five miles of 14-in. and two miles of 8-in. pipe for the Hood River Water Works.

M. Roy Thompson, county engineer for Pierce county, Washington, has announced that the county will re-deck the Lincoln avenue bridge at Tacoma. Plans are being prepared for a drainage district in the tide flats. Albert R. Beymer is assistant county engineer in charge of the drainage work.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

of Western Engineering, published monthly at San Francisco, California, required by the Act of August 24, 1912.

Note.—This statement is to be made in duplicate, both copies to be delivered by the publisher to the postmaster, who will send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the postoffice.

Name of	Postoffice Address.
Editor:	
Chas. T. Hutchinson,	San Francisco, Cal.
Managing Editor:	
Chas. T. Hutchinson,	" " "
Business Manager:	
L. A. Greene,	" " "
Publisher:	
Western Engineering Publishing Co.,	" " "

Owners: (If a corporation, give names and addresses of stockholders holding 1 per cent or more of total amount of stock).

Dewey Publishing Co.,	San Francisco, Cal.
H. Foster Bain,	" " "
Chas. T. Hutchinson,	" " "
L. A. Greene,	" " "
H. F. Dexter,	" " "
H. W. Baker,	" " "
John J. Young,	" " "
T. A. Rickard,	London, England
Edgar Rickard,	" "

L. A. GREENE, Business Manager.

Sworn to and subscribed before me this 20th day of March 1913.

HENRY B. LISTER,
Notary Public in and for the City and County of San Francisco, State of California.
(My commission expires February 1st, 1914.)

Generated on 2024-09-30 00:10 GMT / https://hdl.handle.net/2027/uiug.30112007837781
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN